Commons and Commodity Paradigms: Analysis of the Conflicts Arising from Renewable Energy & Wildlife Policies in the U.S.

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Acronyms
ARRA- American Recovery and Reinvestment Act
BLM- U.S. Bureau of Land Management
CCA- Candidate Conservation Agreement
CREBS- Clean Renewable Energy Bonds
CSP- Concentrated solar power
EIS- Environmental Impact Statement
ESA- Endangered Species Act of 1973
EWG- Exempt Wholesale Generator
FERC- Federal Energy Regulatory Commission
FWS- U.S. Fish and Wildlife Service
GW- Gigawatt
HCP- Habitat Conservation Plan
ISEGS- Ivanpah Solar Electric Generating System
IPCC- Intergovernmental Panel on Climate Change
ITC- Investment tax credit
MBTA- Migratory Bird Treaty Act
MW- Megawatt
NEPA- National Environmental Policy Act
NMFS- National Marine Fisheries Service
ODWC- Oklahoma Department of Wildlife Conservation
OG&E- Oklahoma Gas and Electric Company
PPA- Power Purchasing Agreement
PURPA- Public Utility Regulatory Policy Act
RPS- Renewable Portfolio Standard (also called Renewable Electricity Standard, Alternative Energy Portfolio Standard)
Introduction

Modern society is working to solve environmental problems, such as those linked to climate change, using renewable energy. Climate change is caused by increased concentrations of atmospheric greenhouse gases that are largely emitted by the energy sector (Intergovernmental Panel on Climate Change, 2007b). Many renewable energy options are being developed and promoted extensively as releasing ultra-low or low CO$_2$ emissions as an alternative to conventional fuel sources to mitigate the effects of climate change (L. R. Brown, 2009; Fthenakis & Bulawka, 2004; Milligan, 2004). This solution may exacerbate other environmental issues at the ecosystem level such as wildlife and ecosystem health.

This paper examines current and potential conflicts as an outgrowth of modernity’s threat to natural resources and ecosystems as commodities (Byrne, Glover, & Martinez, 2002; Toly, 2004). The dominance of the commodity paradigm is considered and the value and feasibility of generating new policies and regulations using a commons paradigm is explored. In order to facilitate mutually beneficial outcomes for renewable energy and wildlife based stakeholders, a commons paradigm determines how to manage, modify, and analyze the relationships, conflicts, and policies from a non-commodity benchmark, the long-term viability of ecosystem processes (Byrne & Glover, 2002). The key indicator proposed in this paper for long-term ecosystem viability is biodiversity maintenance or improvement.\(^1\)

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\(^1\) There is substantial research on the use of indicators to analyze complex ecological systems (Bennett, Cumming, & Peterson, 2005; Gunderson & Holling, 2002; Hooper et al., 2005; Kinzig, Pacala, & Tilman, 2002; Levin, 2000; McCann, 2000; Page, 2010; Peterson, 2010; Walker & Salt, 2006). Biodiversity is used here as one indicator of ecosystem health since it is essential to life on earth and impacts to it are seen to be compounded by anthropogenic based threats such as climate change, exploitation of resources, and habitat loss (Hooper et al., 2005). This indicator is evaluated using a paradigmatic model; see Commons vs. Commodity, developed for this paper (See p. 27). There are many more indicators that could be used. The choice of the biodiversity indicator is based on its robust ability to illustrate the difference between commons and commodity oriented thinking and policy.
The intention of this analytical paper is to examine the paradigms surrounding renewable energy and wildlife policy via the evaluation of cases of renewable energy development. It is clear that renewable energy options, like solar and wind, compared to cases of non-renewable energy development, have far fewer environmental problems in scale and quantity. However, rather than comparing the environmental impacts of different technologies within the energy sector, the main intent is to ask whether renewable energy is successfully operating under a paradigm that will foster change in the current direction of the energy development and incorporates not only economic but ecological values such as biodiversity conservation.
Overview

There is vast literature on alternative indicators to assess the ecological health of the extremely complex natural systems. Environmental indicators include, but are not limited to, biodiversity, sustainability, resilience, viability, diversity, modularity, efficiency, stability, productivity, functionality, hierarchies, and scalar and temporal impacts (Bennett et al, 2005; Gunderson & Holling, 2002; Hooper et al, 2005; Kinzig et al, 2002; Levin, 2000; Loreau, Naeem, & Inchausti, 2002; McCann, 2000; Page, 2010; Peterson, 2010; Walker & Salt, 2006). Available literature rightly suggests that this is a complex matter that needs to be looked at through using many criteria. More research needs to be completed to identify multi-criteria models for evaluation of complex/natural systems. While this research relies on a single criterion, the argument is not being made that a single criterion is sufficient. Expansion of this research topic to include multi-attribute analysis should be conducted in the future.

The use of biodiversity as one such indicator in this research is linked to the goal of assessing renewable energy and wildlife policy in terms of commodity versus commons paradigms (these paradigms are discussed starting on page 27). Biodiversity is utilized to reveal the conflicts inherent in designing policies from a commodity versus a commons paradigm.

Evaluating conflicts and cooperation between renewable energy and wildlife conservation policy is essential to diminish negative impacts and coordinate successful rapport between the two. As will be shown below, beginning on page 33, renewable energy policies in the United States operate under a paradigm focused around extensive growth and development. Conflicts can arise between renewable energy policies and wildlife conservation because natural system protection and diversification are often focused on keeping the vitality of the ecological
commons intact in order to ensure minimal long-term impacts to wildlife (Arnett et al, 2007; Berkes, Colding, & Folke, 2000; Fthenakis & Bulawka, 2004; Totten, Killeen, & Farrell, 2010). The renewable energy paradigm of “grow, grow, grow” contradicts the ecological model of “conserve, conserve, conserve.” Innovative policy must be directed at finding ways to create win-win situations for both renewable energy development and wildlife conservation while ensuring that renewable energy operates successfully and sustainably within the ecological commons.

Either discouraging or advancing commons-based practices can allow for positive shifts in solutions for climate, ecosystem, and species health. The United States has built a commodity-based system, taking advantage of a lack of accountability for the commons by monetizing natural resources, pollution, energy, and environmental health. The right to use a commons resource may not be paired with the responsibility to protect it, nor an incentive to invest in or conserve the resource (Hardin, 2005; Levin, 2000; Ostrom & Hess, 2007). Presently, commons-based problems are mistakenly being addressed by the standard commodity system, leading to insufficient conflicts between commons and commodity paradigms.

As concerns about the impacts of climate change on the global commons grows, replacing conventional energy sources with renewable energy technologies is a way to reduce greenhouse gas emissions and mitigate climate change. As a result of climate change concerns, paired with state and federal policies, the rate of growth in the renewable energy sector has been unparalleled in comparison to fossil fuels and nuclear energy development in recent years (L. R.
Brown, 2009). Wind and solar technologies have been particularly dominant in the renewable energy sector during that same time.²

However, this extensive growth in the renewable energy industry, particularly at the utility scale, has created conflict with wildlife as well as the associated conservation and protection policies (Arnett et al, 2007; Fthenakis & Bulawka, 2004; Totten et al, 2010). For example, in 2010 a single wind turbine was installed at the University of Delaware’s Lewes campus and no studies on the impacts of the system to birds, bats, and other wildlife were conducted or required; many believe that the prospect of a green energy alternative exempted the project from normal siting, permitting, and impact assessment procedures (Murray, 2011). Given the importance of maintaining ecological processes and the implementation and development of renewable energy for climate health, it is imperative that decision makers understand the ecological impacts (McDonald, Fargione, Kiesecker, Miller, & Powell, 2009). This understanding will mitigate negative impacts and keep renewable energy as environmentally benign and beneficial to the global and/or ecological commons.

There are appropriate ways in which renewable energy developers can operate in a commons world based around commodity paradigms. To show this, case studies of the conflict of renewable energy development in wind and solar will be assessed in relation to two species, Lesser-prairie chicken (*Tympanuchus pallidicinctus*) and the Desert tortoise (*Gopherus*).

² The rate of growth in renewable energy development originates from a small base of capacity. In contrast, the slow rate of growth in conventional fossil fuels and nuclear energy development is to be expected since the capacity for these technologies is already large. Fossil fuels accounted for approximately 83.5 Quadrillion British Thermal Units (quads) of a total U.S. energy consumption 99.4 quads in 2008. Nuclear energy provided 8.6 quads while solar thermal/PV and wind energy make up approximately 0.01 and 0.5 quads, respectively, during that same period. From 2004 to 2008 wind energy consumption grew from 0.142 quads to 0.546 quads (~384%) and solar thermal/PV grew from 0.065 quads to 0.097 quads (49%) (U.S. Energy Information Administration, 2010b).

The ESA\(^3\) is one of the strongest federal policies protecting species to date. Since its inception, it has provided developers, companies, and landowners ways in which to work in tandem with wildlife and species preservation through exemption clauses. Exemption clauses, although not always the best case scenario for species, encourage cooperation and compliance between stakeholders to mitigate species loss and promote ecosystem health (Endangered Species Act of 1973.2002; D. D. Goble & Freyfogle, 2002; D. D. Goble, Scott, & Davis, 2006; Salzman & Thompson, 2007; Taylor, Suckling, & Rachlinski, 2005). The ESA has been evaluated as having several weaknesses, for example, the evaluation of constitutionality of intrastate versus interstate commerce or the strong protection for individual species over that of ecosystems (Schwartz, 2009). However, the general framework of the policy allows the ESA to advance cooperation between stakeholders.

Other similar wildlife policies, such as the Migratory Bird Treaty Act, do not include such exemptions advocating a cooperative approach, similar to that of renewable energy policy. Although it may seem as though this type of policy provides stronger protection for species, more ambiguity actually exists in terms of prosecution and charges under the MBTA (Migratory Bird Treaty Act of 1918 (title 16, chapter 7, sub-chapter II), 2006). In addition, there is no way in which developers can comply with this policy, as there are no exemptions to the criminal charges (Migratory Bird Treaty Act of 1918 (title 16, chapter 7, sub-chapter II), 2006; Lilley & Firestone, 2008).

\(^3\) Other policies like the Bald and Golden Eagle Protection Act and the National Environmental Policy Act, although not chosen for evaluation here, could be analyzed under a similar framework and may not fulfill the strategic goals for which they are intended.
Although these policies are put in place to reduce direct human influence on wildlife and ecosystems, there is a global threat which can create compounding wildlife impacts on many levels (Byrne et al, 2002; Carpenter & Gunderson, 2001; Ehrlich, 1994; Millennium Ecosystem Assessment (Program), 2005; Parmesan, 2006; Reaka-Kudla, Wilson, & Wilson, 1997; Totten, Pandya, & Janson-Smith, 2003). Anthropogenic climate change is promoting policies to advance zero-, ultra-low, and low carbon energy technologies and development as a solution to the emission of greenhouse gases and thereby exacerbating threats to ecological systems (L. R. Brown, 2009).

**Deterioration of the Global Atmospheric and Ecological Commons: Wildlife and Climate Change**

Climate change, wildlife preservation, and renewable energy do not function in a vacuum. Their conjunctive properties indicate that problems with one cannot be reconciled without solving the problems of another (Ehrlich, 1994; Gunderson & Holling, 2002; Reaka-Kudla et al, 1997; Totten et al, 2010). Ecological and wildlife based issues surrounding anthropogenic climate change will not be resolved without managing them through means that take current commodity-based approaches and apply them within a commons framework. Renewable energy, used as a technological solution to commons-based problems such as climate change, must operate under a commons to continue sustainable progress (*The economics of ecosystems*..., 2011; Byrne & Glover, 2002). Frameworks for this type of model will be explained in more depth in the next section.

Global climate change is caused by an increase in atmospheric concentrations of radiatively active trace gases. There are several dozen of these climate-warming greenhouse
gases, with the main ones including carbon dioxide (CO$_2$), methane (CH$_4$), nitrous oxide (N$_2$O), sulfur dioxide (SO$_2$), and fluoride gases such as hydrofluorocarbons, perfluorocarbons, or sulphurhexafluorides (Intergovernmental Panel on Climate Change, 2007b). Anthropogenic greenhouse gas emissions (often expressed in carbon dioxide equivalents or CO$_2$e), especially those from the energy sector, cause surface temperatures across the earth to increase by making the layer of atmospheric ‘heat-trapping’ gases thicker (Karl, Melillo, & Peterson, 2009). The IPCC has determined that ‘unequivocal’ warming of the earth’s climate is apparent in glacial ice melts and sea level rise. The warming climate is observed in surface, ocean and air temperatures, decreasing snow and ice cover, and an increasing variability of precipitation and extreme weather events (Intergovernmental Panel on Climate Change, 2007b). Over the last 100 years there has been a 0.74 degree Celsius increase in global average temperature. Please see Appendix, Figure A1 which illustrates the physical and biological changes as a result of global surface temperature change.

The rate of global average sea level rise has been increasing over the last fifty years. From 1961-1993, the rate of global average sea level rise was an average of 1.8 mm/yr and from 1993-2003 the rate of was 3.1 mm/yr (Intergovernmental Panel on Climate Change, 2007b). Precipitation is expected to increase significantly in some parts of North America, albeit in erratic patterns such as more frequent and severe flooding (e.g. 100-, 500-, and 1000- year floods recurring in periods of years and decades), in addition to the increase in variation and events of extreme weather.

The Intergovernmental Panel on Climate Change (IPCC) found there is a greater than 90% probability that the observed average global climate change is due to anthropogenic sources (Intergovernmental Panel on Climate Change, 2007b). Natural temperature variability has been
invalidated as a primary, let alone the sole reason, for climate change. The IPCC 4th Assessment Report provides one example, showing the sources of global radiative forcing measured in watts per square meter (W/m²) (see Figure 1 below—red colored bars are warming the global temperature while blue bars have cooling effects). The IPCC divides the drivers into human activities and natural processes. The major natural process is from solar irradiance, or the increased output of the sun (volcanic explosions are another minor natural source). If comparisons were done between the solar radiative forcing under natural processes, which appears to be ~0.01 W/m², with the next row on the total NET human activities of ~1.6 W/m², then human radiative forcing is about 15 times greater than solar forcing. The anthropogenic emissions are currently around 50 billion tons, or gigatons (Gt) of CO₂e. Therefore, natural radiative forcing causes such as the sun, have the effect of only approximately 3 GtCO₂e (Forster et al, 2007).

Levels of global greenhouse gas emissions have increased drastically since before the industrial era. The IPCC estimates greenhouse gas emissions into the global atmospheric commons as a result of human activities increased 70% from 1970-2004. Carbon dioxide is one of the most significant greenhouse gases, as its annual growth was as much as 80% during the same period (Intergovernmental Panel on Climate Change, 2007b). The increase is primarily due to fossil fuel use in the transportation, utility, agricultural, and industrial sectors as well as for residential and commercial building uses (Karl et al, 2009). In addition, nearly 20% of global CO₂e emissions have been due to tropical deforestation of some 13 million hectares per year over the past half century.
Figure 1. Radiative Forcing of Climate Between 1750 and 2005
Source: Forster et al, 2007

Note: Summary of the principal components of the radiative forcing of climate change. All these radiative forcings result from one or more factors that affect climate and are associated with human activities or natural processes as discussed in the text. The values represent the forcings in 2005 relative to the start of the industrial era (about 1750). Human activities cause significant changes in long-lived gases, ozone, water vapour, surface albedo, aerosols and contrails. The only increase in natural forcing of any significance between 1750 and 2005 occurred in solar irradiance. Positive forcings lead to warming of climate and negative forcings lead to a cooling. The thin black line attached to each coloured bar represents the range of uncertainty for the respective value. (Figure adapted from Figure 2.20 of this report.)

When breaking down the greenhouse gas emissions by sector, the energy sector is responsible for about 26% of global greenhouse gas emissions, while the transportation sector is about 13%, and industry accounts for almost 20% (Intergovernmental Panel on Climate Change, 2007b). Globally, about 75% of all carbon dioxide emissions are a result of anthropogenic
combustion of fossil fuels, while much of the remaining amount is a result of deforestation and agriculture (Karl et al, 2009).

Figure 2. Greenhouse Gas Emissions by Sector in 1990 and 2004.
Source: Barker et al, 2007

Note: GHG emissions by sector in 1990 and 2004 100-year GWPs from IPCC 1996 (Second Assessment Report (SAR)) were used to convert emissions to CO2-eq. The uncertainty in the graph is quite large for CH4 and N2O (in the order of 30–50%) and even larger for CO2 from agriculture and forestry. For large-scale biomass burning, averaged activity data for 1997–2002 were used from Global Fire Emissions Database based on satellite data. Peat (fire and decay) emissions are based on recent data from WL/Delft Hydraulics. [Figure 1.3a]

The billions of tons in CO2 equivalent emissions in 2004 for Anthropogenic sources would be: Energy ~12.5 GtCO2e; Transport 6.5 GtCO2e; Buildings ~4 GtCO2e; Industry ~9.5 GtCO2e; Agriculture ~6 GtCO2e; Deforestation and Land Change ~8.5 GtCO2e; Waste and wastewater ~1.5 GtCO2e; TOTAL ~49 GtCO2e.

Global greenhouse gas emissions are expected to increase in the next 20 years as commodity-based fossil fuels continue to play a large role in energy systems. According to the
IPCC, if greenhouse gas emissions continue at or above current emissions rates, warming and other climatic events will continue to grow and will (at a greater than 90% probability) be larger and more pronounced in future centuries than is currently observed. Warming of around 0.2 degrees Celsius is projected in the near term in the absence of reduced greenhouse gas emissions. Even if emissions levels decreased to levels observed in the year 2000, changes in climate would still occur (Intergovernmental Panel on Climate Change, 2007b). In addition current emissions, particularly carbon dioxide, have the potential to cause irreversible (until at least the year 3000) damage to global systems, even if emissions were to stop immediately (Solomon, Plattner, Knutti, & Friedlingstein, 2009).

Ecosystem Impacts

The IPCC recognizes that greenhouse gas emissions have had an impact on the physical and biological commons throughout the globe, posing new challenges and conflicts for conservation, ecosystem health, and emissions management. Evidence exists from all continents and most oceans that confirm that regional natural systems are affected by climate change. The IPCC states that approximately 20–30% of species will be at an increased risk of extinction if global average temperatures increase by between 1.5–2.5 degrees Celsius (Intergovernmental Panel on Climate Change, 2007b). In particular, land regions are expected to warm faster than oceans (Intergovernmental Panel on Climate Change, 2007b). Disturbances such as floods, droughts, wildfires, pests, ocean acidification, land use alterations, pollution, and over-use of resources in conjunction with other impacts of climate change will quickly lead to surpassing ecosystem resilience (the ability to retain functionality and structure in the presence of disturbance) (Intergovernmental Panel on Climate Change, 2007a; Walker & Salt, 2006).
In addition, more recent research has indicated that global tropical forests are especially at risk of climatic change. Many species in humid tropical forests often operate within narrow climate ranges in comparison to species in temperate regions, and small climate changes may have significant impacts (Asner, Loarie, & Heyder, 2010). In the past few years, research has increasingly indicated that IPCC projections of average temperature increases in a business-as-usual model are likely to underestimate future change (Rahmstorf et al, 2007; Webster et al, 2009). Increases of up to six degrees Celsius, two to three times greater than IPCC worst case scenario estimates, have been proposed, putting ecosystems at extreme risk (Webster et al, 2009). At these potential temperature increases, global humid tropical forests may only retain about 20% of their current biodiversity (Asner et al, 2010).

There is additional evidence that climate change is causing a shift in the timing of natural and biological events such as leaf unfolding, bird migration, and egg laying. These shifts have several consequences. First, lifecycles of pests and crops are beginning earlier than normal, potentially allowing for pests to phase through two lifecycle in the time period when they originally had one (Intergovernmental Panel on Climate Change, 2007a). Second, increasingly northern range extensions and earlier migration timing have severe consequences for biodiversity loss and ecosystem function, especially for spatially restrictive landscapes and range-restrictive species (Goudard & Loreau, 2008; Parmesan, 2006). They affect the ability for species to interact with the other species and resource bases, creating a disparity between species and the resources they need to survive (Goudard & Loreau, 2008; Intergovernmental Panel on Climate Change, 2007a; Karl et al, 2009; Parmesan, 2006). Adding further issues of resource/species compatibility, species ranges, both terrestrial and aquatic, are shifting upward in latitude and toward the poles (Intergovernmental Panel on Climate Change, 2007a).
Increasing emissions levels have been seen to impact marine systems, which in turn impact terrestrial and freshwater systems. Approximately $27 \pm 5\%$ of emissions emitted into the atmosphere are taken up by the ocean, resulting in increased ocean acidification (Bernie, Lowe, Tyrrell, & Legge, 2010). Ocean surface pH has decreased from 8.16 in the year 1750 to 8.07 in 2010, and continues to decrease at the fastest rate in the last 55 million years (Bernie et al, 2010). Ocean acidification reduces Calcium carbonate ($\text{CaCO}_3$) concentrations which may cause ocean habitats, like coral reefs, to degrade, severely impacting marine ecosystems. This has the potential to impact the global food system as well as local populations that depend on marine resources (Bernie et al, 2010).

Increasing ocean temperatures due to climate change are also having remarkably large impacts on global phytoplankton, which have a vital function for life on Earth, producing approximately half of Earth’s organic material. Phytoplankton are a basis of marine food webs, have roles in ocean circulation, fisheries health, and geochemical cycling (especially the carbon cycle) (Boyce, Lewis, & Worm, 2010). The compounded impacts as a result of declines in phytoplankton levels can be catastrophic to global systems.

Climate change impacts on biodiversity and ecosystems vary greatly depending on the magnitude and intensity of the change as well as on mitigation strategies to facilitate decreased climate change threat and increased adaptability. Both adaptation to and ambitious mitigation of climate change are necessary and essential to help reduce impacts, although the trillions of tons of past and current $\text{CO}_2$ emissions will result in a certain level of unavoidable impacts (even if emissions could be miraculously stopped tomorrow) (Solomon et al, 2009).
Ecosystem and species vulnerability depends not only on climate change, but also the ecosystem’s susceptibility to non-climatic stresses such as disease, habitat loss and over exploitation of resources (Reaka-Kudla et al, 1997). Often in ecological and climate systems, there are lag times and threshold effects between actions and consequences (Ehrlich, 1994). For example, the elimination of one habitat may not immediately threaten a population, but it may have greater compounding affects over time as the species that relied on the habitat are lost and the species that depended on them and so on (Ehrlich, 1994; Loreau et al, 2002; Schwartz, 2009; Tilman, 2000).

Additionally, the opportunity for these cascading effects are extremely difficult to measure and may cause an underestimation in the rate of current and projected species loss (Ehrlich, 1994; Gunderson & Holling, 2002). The longer it takes to reduce emissions, the less opportunity there is to decrease the risk of climate change impacts on species and ecosystems (Intergovernmental Panel on Climate Change, 2007b). Healthy ecosystems are more robust and resilient than degraded ones, which helps lessen the impacts of extreme weather events and increase the ability for humans as well as other species to adapt to a changing climate (Conservation International, 2011b).

These compounding effects from climate change serve to further illustrate that commons-based issues like those associated with climate change, wildlife, and ecosystem health need to be solved with commons-based approaches (Totten et al, 2003). Renewable energy has the potential to mitigate many of the effects of anthropogenic climate change. However, by addressing climate change in this way, other environmental conflicts tend to emerge.
Wildlife Conflicts with Renewable Energy

In response to climate change, species are increasingly susceptible to impacts from not only climate change, but the technological solution showcased to mitigate its effects (Ehrlich, 1994; Reaka-Kudla et al, 1997). Wildlife impacts must be addressed in order to mitigate or eliminate this conflict to allow renewable energy to operate successfully and sustainably in the global and regional commons.

Renewable energy options are not environmentally neutral, although they are better than most conventional alternatives. For example, Sovacool (2009) calculated the approximate number of birds killed per capacity generated by wind turbines 0.3/GWh, nuclear 0.4/GWh, and fossil fuels 5.2/GWh (Sovacool, 2009). Since these estimates are generation based, it can be presumed that given current practices, increased development has the potential to increase negative environmental impacts. Impacts from renewable energy can be from any stage in the construction, installation, or retirement of the system and many of them are site specific and depend on the type, size, and location of the energy generation project (Arnett et al, 2007; Jacobson, 2009; Tsoutsos, Frantzeskaki, & Gekas, 2005).

Wildlife impacts are often quantified as being direct or indirect. Direct impacts are those that result from generation technology construction, physical collisions with structures (i.e. turbines or panels) and human access. Indirect impacts are those that result from or cause habitat fragmentation, loss of habitat, habitat avoidance, and other associated issues (Arnett et al, 2007). Impacts can also have short-term or long-term effects. Short-term effects are most often limited

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4 It is important to note here that since wind energy systems comprise a small portion of the U.S. total energy generation, the scale of impacts is decreased. To put this into perspective, in 2006, approximately 7,000 birds were killed by wind energy systems, 327,000 by nuclear power, and 14.5 million by fossil fuels (coal, oil, and natural gas) (Sovacool, 2009).
to within the construction period while long-term effects are those that are more chronic and cause extended displacement for the lifetime of the project. Determining these classifications depends on the species of interest, the potential for habitat restoration, renewable energy technology, and the inherent characteristics of the site (Arnett et al, 2007).

Direct Impacts

Several wildlife families have been found to be most directly influenced by wind and solar development, including raptors, migratory nocturnal passerine species, grouse, and bats. Of these, there has been special emphasis on understanding the negative impacts on migratory birds. This concern is magnified by the facts that not only do mass migrations occur through North America every year but also such birds are given extra legal protection under the Migratory Bird Treaty Act (MBTA) and its subsequent definition of “take” (Lilley & Firestone, 2008). Region placement of wind turbine and utility scale solar placement are an important variable in the amount of direct impacts faced by species.

Avian Impacts

Wind energy facilities have direct impacts on wildlife, particularly turbine blade collisions on in-flight avian species. In a study of the collision impact on avian species from wind turbines (in the U.S. outside of California), 78% of the fatalities were passerines that are under the protection of the MBTA (Erickson et al, 2001). Low flying passerines may have an increased threat of mortality due to wind turbines since their flight heights fall within the range of turbine heights and since the species may respond to topographic cues that are similar to the paths that wind resources follow (Mabee, Plissner, Cooper, & Young, 2006). For example, an increasing amount of recorded passerine fatalities have been reported per turbine on forested
ridge tops in the Eastern United States (Erickson et al, 2001; G. D. Johnson et al, 2002; Manville, 2005). Additionally, passerines that migrate at night when cloud ceilings are low and mountain ridges are high along forested ridge tops may suffer higher mortalities due to limited height elevation (G. D. Johnson et al, 2002). This decreases the amount of safe fly zone surrounding the rotor-swept area of the wind turbines, increasing the chance of collision and fatalities.

It is often believed that raptors may fall victim to collisions through attempts to use wind turbine masts as perching sites. Raptor collision risks are increased depending on the type, height, and site of the wind turbine, as well as the abundance of birds within the wind turbine construction area and age of technology (Arnett et al, 2007).

Birds, and predictably less often bats, may fall victim to collisions as a result of ecological traps due to the reflectivity of horizontally polarized light off of the surface of many models of solar cells (Horvath et al, Submitted 2009). This reflective quality may mimic areas of water that many birds may find attractive, thereby causing collisions. Roads after a rain storm are the most prominent example of this behavior by birds and bats. These occurrences often happen at night and therefore affect species which migrate primarily during that time period (Hötker, Thomsen, & Jeromin, 2006).

Intense collision effects, such as these, are likely more detrimental for raptors and bats than for other avian species since they have shorter lifespan turnovers and lower reproductive rates. As a result, raptors and bats may not be able to adapt as quickly to the development of wind and solar energy facilities and therefore may be more adversely affected (National Research Council, 2007).
**Non-Avian Impacts**

In addition to avian species, there also exist special collision concerns for flying mammals (Boyles, Cryan, McCracken, & Kunz, 2011). There are 45 species of bats in North America above the U.S. border with Mexico, and 11 of those species have recorded fatalities from wind energy facilities (G. D. Johnson, 2005). Bat fatalities appear heavily skewed to migratory foliage roosting species that include the hoary bat (*Lasiurus cinereus*), eastern red bats (*Lasiurus borealis*), and migratory tree-roosting silver-haired bats (*Lasionycteris noctivagans*) (Arnett et al, 2007; Boyles et al, 2011). There have yet to be any records of endangered or threatened bats killed by wind turbines (Arnett et al, 2007).

It is plausible that these wind turbines disrupt echolocation abilities in bats that would allow them to be able to bypass the rotor-swept area. Potential distribution of prey species has also been hypothesized to cause an attraction of bats to wind turbine areas (Arnett, 2005; Kunz, Arnett, Cooper, Erickson, Johnson et al, 2007). According to Kerns et al (2005), bat fatalities in West Virginia and Pennsylvania due to wind turbines increased during autumn when bats most often migrate. They also found that more males than females are killed by turbines in these areas. This may be a result of any number of factors, including but not limited to migratory movement, mating rituals, and an abundance of prey species (Kerns, Erickson, & Arnett, 2005).

As importantly, bats have not been observed to suffer collisions and ultimate fatalities with any part of the turbine that is not moving (i.e. the mast, non-moving blades, or towers). Bats were observed to collide with the turbines when the blades were moving at approximately their fastest. Blade speed, however, is not always indicative of high wind speeds. In such circumstances when the wind level is low but blade speed is relatively high, the highest bat and other avian species fatalities and collisions occur (Arnett et al, 2007; Kerns et al, 2005).
Bats may be in a more susceptible situation in comparison to other avian species due to instances of barotrauma, described by the “decompression hypothesis” (Baerwald, D'Amours, Klug, & Barclay, 2008; Lilley & Firestone, 2008). Low-pressure zones are created behind wind turbines as energy from the wind in front of the turbine is transferred to the generator within the turbine. Pulmonary barotrauma occurs when tissues over-expand from pressurized air; and without exhalation of this expanded gas, can cause hemorrhaging (Baerwald et al, 2008). Although exact pressures required to cause barotraumas in bats are unknown, it has been shown that pressure drops of as little as 4.4 kPa may kill other small mammals such as Norway rats (Rattus norvegicus), a pressure drop well below the range of pressure in the area behind wind turbines (5-10 kPa) (Baerwald et al, 2008; Dreyfuss, Basset, Soler, & Saumon, 1985).

Bats are also more biologically susceptible to barotraumas in comparison with avian species (Baerwald et al, 2008). Bats have mammalian lungs, meaning that they are large, pliable, and expand when exposed to pressure drops. Conversely, avian species have dense, compact lungs as well as strong pulmonary capillaries that allow for limited affects when exposed to large pressure changes. Barotrauma has yet to be posited as a reason for bird mortality from wind turbines (Baerwald et al, 2008; West, Watson, & Fu, 2007). Baerwald et al (2008) reported what they deem to be the first evidence of barotraumas that caused a higher proportion of bat fatalities in comparison to avian species. Seventy-five fresh bats (hoary and silver-haired) at a wind energy facility in Alberta, Canada were necropsied in the field. Of those, 34% had external (collision based) injuries as well as internal hemorrhaging, 57% had internal hemorrhaging and no external injuries, and 8% had external injuries but no internal hemorrhaging damage (Baerwald et al, 2008).
Indirect Impacts Through Habitat Impacts, Disturbances, and Fragmentation

The mere placement of wind turbines and solar fields alter the landscape, displace wildlife, cause noise disturbances, and modify overall use of that habitat by wildlife. Road construction, turbine pad construction, solar ground mount systems, construction staging areas, installation of electrical substations, housing for control facilities, and transmission lines connecting the facility to the power grid are sources of habitat disturbances for wildlife (Arnett et al, 2007; International Energy Agency, 1998).

In comparison to many forms of non-renewable energy generation, wind turbines have been seen to have relatively low indirect impacts to wildlife. The U.S. Bureau of Land Management (BLM) estimated, in an Environmental Impact Statement of wind energy facilities, that permanent habitat damage is approximately 5–10% of the total area needed for development of a facility (Bureau of Land Management, 2005). Short-term direct habitat disturbance is upwards of three times greater than permanent, depending on reclamation time (Arnett et al 2007). This is primarily due to the large pathways that result from construction equipment and the space needed to transport the turbine blades which are often greater than 40m in length. Equipment and construction storage are also areas of short-term disturbance that may help speed reclamation time once rendered unnecessary (Arnett et al, 2007). Reclamation time variability based on ecosystem type also needs to be taken into account when determining impact footprints of wind energy facilities. For example, grasslands (2–3 years) can be reclaimed much more quickly than impacted desert ecosystems (>10 years) (Arnett et al, 2007).

Disturbance goes beyond land use impacts. At a certain point, different species reach a threshold of tolerance for habitat disturbance and may avoid habitat areas completely. Those wind turbines and solar facilities that have a high instance of human involvement and
maintenance, and animals with a low threshold for tolerance for habitat intrusion, will be those that have the highest habitat avoidance rates (Arnett et al, 2007).

Utility scale, centralized photovoltaic and concentrated solar power systems, in particular, require large areas that have the potential to disrupt habitat and impact ecosystem function and health. The impacts due to land use depend on topography, type of habitat, local ecosystem type and societal value, and incidence of biodiversity and endangered species (International Energy Agency, 1998; Tsoutsos et al, 2005). The amount of land that undergoes alteration also depends on the type of technology and energy system applied to that land. Types of mounts, tracking ability, array tilt degree variation and orientation, self shading potential, maintenance systems and access roads, and energy storage facilities all affect the amount of land utilized or disturbed by that system (Denholm & Margolis, 2008; Jacobson, 2009; Tsoutsos et al, 2005). On average, for every 20-60 MW generated by a utility scale solar power plant, ~1 km$^2$ of land is needed (Union of Concerned Scientists, 2010a).

In addition to land use impacts, concentrated solar power plants often require water for use as a coolant. Areas like the arid southwest U.S. where solar system potential is the greatest, are often those areas where water use is most detrimental and energy intensive. In addition, there is the potential for water pollution to occur due to thermal water discharges causing damage to already water-strained ecosystems (Tsoutsos et al, 2005; Union of Concerned Scientists, 2010a).

Avian Impacts

Grassland birds have been disproportionately affected by indirect impacts of wind turbine introduction into their habitats. Grassland habitats in the Great Plains of the U.S. are already suffering from increased habitat fragmentation due to human intrusion and disturbance in
previously undisturbed areas (Knopf & Samson, 1997). Transmission availability and impacts aside, the area of the U.S. inhabited by grassland birds has the greatest wind resources as well as the fewest logistical barriers to construction (Weinberg & Williams, 1990). Currently wind energy in these areas is being extensively developed.

Grassland birds have habitat preferences. As a result, the potential influence of a wind turbine construction and operation within a habitat is often unknown and could be significant. According to Leddy, et al (1999), densities of grassland birds were noticeably lower in areas of southwestern Minnesota that were home to wind turbines. A positive correlation surfaced between distance from turbines and increasing population densities. Researchers attribute this correlation to: decreased habitat effectiveness as human disturbances were increased, avoidance of turbine and maintenance noise, and the edge-averse nature of several species of grassland birds. In addition to edge-averse preferences, several species exhibited partialities towards an avoidance of trees and preferences toward larger plots of grassland with open horizons, and similar correlations and findings of preference have been found throughout the Great Plains (Erickson, Jeffrey, Kronner, & Bay, 2004; D. H. Johnson, 2001; G. D. Johnson, Erickson, Strickland, Shepherd, & Shepherd, 2000; Leddy, Higgins, & Naugle, 1999).

Non-Avian Impacts

Wind energy development may also impact large mammals, but little information about habitat impacts exists. It is generally understood that with the construction and operation of wind turbines there will be, at a minimum, a level of temporary habitat avoidance due to disturbances. However, seasonality of construction does play an important role in determining impacts. Since construction usually does not occur in the colder winter months, this has the benefit of lessening
impacts to wintering ungulates (i.e. hoofed mammals like deer). However, road construction may fragment ungulate habitat enough to decrease range and may result in individuals utilizing smaller patches of land that may be less suited (C. B. Brown, 1992). “These impacts could be negative and perhaps biologically significant if facilities are placed in the wrong locations, particularly if the affected area is considered a critical resource whose loss would limit the populations” (Arnett et al 2007:27). Conversely, many mammalian scavengers, such as coyotes and raccoons, may be positively affected by bat and bird fatalities surrounding wind turbines (Kunz, Arnett, Cooper, Erickson, Larkin et al, 2007).

Exploration into the effect of anthropogenic disturbances on black bears (*Ursus Americanus*) has recently shown that there is a potential for great impacts. Studies have most explored potential impacts on denning black bears. Black bears have been shown to select dens in sites approximately one to two kilometers from the closest areas of regular human activity (Linnel, Swenson, Anderson, & Barnes, 2000). Human activity that occurred outside of 1 km from the den was mostly viewed to be tolerated while activity within approximately 1 km of the den leads to den abandonment. Although the abandonment of one den may not be problematic for a population, abandonment at a larger scale can have serious detrimental affects to populations due to cub mortality (Linnel et al, 2000).

Adaptation to disturbances such as wind turbines can occur on a species to species basis. In the case of California ground squirrels (*Spermophilus beecheyi*), coping mechanisms through anti-predator behavioral modifications have been observed as due to noise disturbances from wind energy facilities (Rabin, Coss, & Owings, 2006). However, these adaptations happen more quickly for species with rapid life cycles and are often only temporary fixes for a larger issue.
The dilemma of polarized light pollution has been found to impact aquatic insects for a different reason. Over 300 species of insects, such as mayflies, stoneflies, and tabanid flies are considered to be polarotactic, attracted to the horizontally polarized light reflecting off bodies of water which is mimicked by solar arrays and mirrors. The aquatic insects use this type of light reflectance as an evolutionary and behavioral cue to identify the presence of water and associated areas in which to oviposit (lay eggs). Ovipositing on artificial, non-water surfaces results in widespread predation, mortality and reproductive failure potentially causing rapid population declines or collapse (Horvath et al, Submitted 2009). These negative impacts are predicted to be especially prevalent when large-scale solar energy technologies are located near wetlands and water bodies such as oceans, rivers, and lakes (Horvath et al, Submitted 2009).

Each of the impacts indicated above represents a way in which the responsibility for the ecological commons is being neglected. This indicates a conflict between current development frameworks and those consistent with supporting global atmospheric and ecosystem health. For additional listings of impacts please refer to the Appendix, 2 Wildlife Impacts from Solar PV, Solar CSP, and Wind Energy Generation Technologies.
Commodity vs. Commons: How Renewable Energy can be an Environmental Problem

Conflicts in the Commons: An Overview

Roughly since industrialization, modern society has been operating in a paradigm\(^5\) centered on the commodification and optimization of exchange of natural resources, ecosystems (both services and wildlife), and energy (Byrne et al, 2002; Toly, 2004; Walker & Salt, 2006). The growth of the conventional energy system, primarily based on minerals and fossil fuels, has been using natural resources for the good of human energy development. The conventional energy regime has participated actively in this commodification of nature with the estimated value of extracted resources over the last sixty years exceeding $8.1 trillion (Byrne & Glover, 2002; Byrne et al, 2002; U.S. Energy Information Administration, 2010a).\(^6\)

Although social needs can and have been successfully met by commodification (depending on how societies value commodities and social needs), there can be adverse environmental consequences. Important among these in the case of energy commodification is the risk of climate change. To avert the impacts of climate change from the energy industry, Byrne et al (2009) argue that energy commodification must be replaced by a commons-based approach. In a commons approach, the right to use a resource may be paired with the responsibility to sustainably use the resource and protect ecosystem health (for example, by

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\(^5\) The concept of a paradigm shift, as defined here, originated with Thomas Kuhn and his book *The Structure of Scientific Revolutions* (1962). Kuhn dismisses the idea of normal science and linear study, replacing it with a dynamic revolutionary science where anomalies, assumptions, and alternatives to standard paradigms are explored. In essence, scientific theory does not follow a fixed progression focused around the accumulation of facts and knowledge, but conversely a variable process of conditional ever-fluctuating thought during which new questions and thoughts are applied to old information (Kuhn, 1962).

releasing no more carbon than the planet’s carbon cycle can naturally absorb) (Byrne & Glover, 2002).

Essentially, all people with a right to use the commons must practice under a social system of restraint to help protect, conserve, and keep the resource at sustainable levels. Irresponsibility of societies participating in a commons can lead to the ruin of the system for society. For example, if a commons area consists of the land needed to graze sheep, individuals may seek to keep adding sheep to the grazing land to maximize person gain, but doing so would fail to manage the land in a sustainable fashion for the good of society and the environment (Hardin, 2005).

Historically, in order to solve this problem, the commons have been broken up via property rights and have been privatized (Ostrom & Hess, 2007; Toly, 2005). However, this has not always worked as expected as supporting a single solution to the management of all resources has created conflict (Ostrom, 2010). In a privatization strategy, valuation of the commodity is done through a market framework whereby resources are broken up into discrete items for sale (Ostrom & Hess, 2007; Toly, 2005). The “valued” resource flows through a market framework along with the direct costs associated with them (Costanza et al, 1997). However, many of the indirect costs to the ecological commons (such as impacts on wildlife) do not flow through markets. Impacts to wildlife, wildlife, and ecosystem services, which correlate to ecosystem health, are often not valued in the commodity framework. Even the benefits of renewable energy, those associated with global climate change, are not significantly valued in the commodity-based market where renewable energy is a participant (Byrne et al, 2002; Totten et al, 2010). In addition, the negative externalities of conventional fuels are not accounted for within this same market.
Energy Commodification and Commons Conflicts

Although the development of renewable energy has been seen as an important solution to global commons problems, it can cause conflict with other environmental values, for example, those centered on biodiversity preservation (L. R. Brown, 2009). Renewable energy has the potential to present itself in one of two ways: a commodity similar to the conventional energy resource model now in use; or a commons-based approach. In the former, “success” means enabling environmental growth at competitive cost. In the latter, “success” means the use of a renewable resource in a non-harmful manner, placing sustainability above optimality (Pezzey, 1997; Walker & Salt, 2006). The commodification model often disregards the commons values intended to enhance environmental value as the long-term goal. Even when a laudable purpose such as expanding renewable energy supply is pursued, the commodification model can present environmental conflicts, leading to loss of resilience in those systems (case studies analyzed in this paper will discuss this potential in detail).

Current development of the energy industry of fossil and mineral based fuels functions under a growth and development precept (Byrne, Martinez, & Ruggero, 2009). Continued growth of energy use and energy supply is encouraged not only in legislation, it is also often the intent of technology innovation. The renewable energy industry often champions this growth model but obviously seeks preferences for its product. The energy sector within the commodity paradigm of continued growth counters that of wildlife conservation and associated policy focused on keeping wildlife and ecosystems in their unaltered, unaffected forms. Although renewable energy, specifically, has been depicted as being environmentally benign, when renewable energy is developed in a commodity framework like the one under which mineral and
fossil based fuels operate, conflict can result (Byrne & Glover, 2002; Byrne et al, 2009; Toly, 2005).

When renewable energy works in a similar fashion to fossil and mineral based fuels, the growth precept is maintained and the benefits of renewable energy and wildlife preservation within the capitalist system continue to be devalued. If society uses renewable energy to fill what is encouraged to be insatiable energy demand, the growth mentality persists (Byrne et al, 2009). However, if society as a whole uses renewable energy within the commons framework in order to make changes in behavior and address social issues, this conflict in the commons is diminished. If renewable energy is to become viable and mainstream with the purposes of mitigating climate change and promoting ecosystem health, society must ensure renewable energy operates under a commons-based paradigm.

Table 2 below is designed to give more clarity to the potential options explored in the subsequent sections. Cell I shows the potential for operation within a commons-based paradigm, and for the purposes of this research, serves as the ideal model for conflict reduction. Cell IV is the most problematic as it uses all or nothing policies for wildlife and pairs them with conventional fuel sources. In this way, the impacts of the energy sector on the commons are not addressed and a commodity paradigm is perpetuated.
Table 1. Paradigm Designation Matrix

<table>
<thead>
<tr>
<th>POLICY</th>
<th>PROPERTY</th>
<th>Commons</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commons</td>
<td>I</td>
<td>Shared commons natural resource (e.g. solar radiation or wildlife) regulated by policy that addresses needs of multiple stakeholders or resources</td>
<td>II</td>
</tr>
<tr>
<td>Commodity</td>
<td>III</td>
<td>Shared commons natural resources (e.g. solar radiation or wildlife) but regulated by policy that addresses needs of a single stakeholder or resource</td>
<td>IV</td>
</tr>
</tbody>
</table>

In order to determine where renewable energy and wildlife initiatives fit within this matrix, policies that are currently in place must be evaluated to indicate their commons or commodity characteristics.
Does Renewable Energy Work Within a Commodity or Commons Paradigm?

As a result of climate change concerns and policy incentives, the rate of growth in the renewable energy sector has been unparalleled in comparison to fossil fuels and nuclear energy development in recent years (L. R. Brown, 2009). It is increasingly apparent that wide scale policy support for the expansive growth and development of renewable energy often conflicts directly with the goals of wildlife preservation and the promotion of a healthy ecological commons. In addition, the policies evaluated that encourage the growth in renewable energy sector do not factor in concerns or provisions for wildlife health. Wind and solar technologies have been particularly dominant in recent years and will be evaluated in tandem to several state and federal policies promoting growth in the sector.

Wind

The addition of new wind turbines to the grid can displace part of the need for conventional fuel systems. The emissions and pollutant benefits accumulate as a result of reduced consumption of fossil and mineral based fuels. Emissions reductions are a function of the energy generation it offsets: the higher the emissions from the original power plant, the greater the emissions reductions from using wind to generate that energy (Milligan, 2004).

Energy from wind is a particularly appealing concept since wind resources are abundant, cannot be depleted, and are widely distributed throughout the world (L. R. Brown, 2009). The U.S. in particular has a plentiful endowment of wind and enough land to sustain the development of wind energy, in an amount capable supplying the entire country’s electricity needs. In addition, wind development is relatively easy to scale up in size and is relative quick to implement (L. R. Brown, 2009).
Global wind energy installed capacity is growing rapidly, with trends leaning toward large economies of scale and multi-megawatt turbine installations (Pasqualetti, Righter, & Gipe, 2004). Global generating capacity has grown from 17 GW to 121 GW between the years of 2000–2008. As of October 2010, the cumulative wind power installations in the U.S. were approximately 36,698 MW (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010c). (See Appendix, Figure A2: Current Installed Wind Power Capacity (MW)). Availability of grid connections for wind farms is a limiting factor, and as of 2009 there were 300 GW of wind capacity pending available grid connection (L. R. Brown, 2009).

As touched upon earlier, the Great Plains is the region of the U.S. best identified, and receiving the most attention, for wind resources. (See Appendix, Figure A3: 80-Meter Wind Map and Wind Resource Potential). The region’s environment lends itself to growth in the wind energy sector based on climate and topographic characteristics. Much of the economy of the Great Plains, historically speaking (post-18th century), has been based on agriculture and land use. Farmers and private landowners have been capitalizing on the economic benefits from wind while continuing to make use of their land as before (Pasqualetti et al, 2004). In these ways, the Great Plains are suitable for wind development for both natural and cultural reasons.

In terms of land requirements, wind turbines are extremely efficient since they are vertical structures. The turbines themselves account for only 1% of the total land used by a wind farm (L. R. Brown, 2009). However, land resource disturbances occur not only from the pads that house the turbines, but the access roads, edge effects, buildings, and transmission lines associated with the technology. Wind farms are also appealing to investors and private landowners (for example farmers or ranchers) since the land surrounding wind farms can be cultivated or used for livestock grazing, increasing the commoditized economic production on
the property. Specifically in the Great Plains, royalties in the amount of $3,000-10,000 per wind
turbine are provided to landowners who allow for construction and development on their
property (L. R. Brown, 2009). These royalties spur additional tax revenue for local
communities and competition for wind development within communities and landowners (L. R.
Brown, 2009).

Solar

Each hour, the sun provides the earth enough energy to power an entire year of human
civilization’s total energy use (Krupp & Horn, 2009). The amount of radiated energy from the
sun that reaches the earth’s surface is approximately 160 trillion kW. It is only 4.8x10^-8% of the
total energy radiated from the sun (L. R. Brown, 2009). To put it into perspective, if only 10%
of that solar radiation were converted to electricity, to provide the U.S. with power, a swatch of
land needed to power the system would be about 100 square miles (Krupp & Horn, 2009). As of
2007, total global solar capacity was around 6.6 GW, while coal capacity is approximately 1000
GW. This resulted in solar power providing only approximately 0.5% of total global electricity
supply (Krupp & Horn, 2009). Solar heating, cooling, and electric installation totals increased by
approximately 18% from 2008 to 2009 (Sherwood, 2010). (See Appendix, Figure A4: Number of
Annual Solar Installations by Technology (2000-2009)).

Solar Photovoltaics

Solar photovoltaics convert sunlight directly into electricity using semi-conductor
materials and does not require mechanical or thermal energy inputs (L. R. Brown, 2009;
Sherwood, 2010). Solar power is most productive during times of the year when solar radiation
is the greatest (during sunny and hot days), the same times of the year when human energy
demand peaks. As a result, solar power is beneficial, not only for environmental concerns, but also for utility operations (Krupp & Horn, 2009). The greatest resource potential in the U.S. is found in the Southwest (National Renewable Energy Laboratory, 2010c). (See Appendix, Figure A5: Photovoltaic Solar Resource of the United States).

Photovoltaic systems do not produce noise, toxins, or greenhouse gases as a result of electricity generation. The zero emissions electricity generation of solar photovoltaics is one of the single most compelling characteristics that warrant the use of solar power to combat climate change (Fthenakis & Bulawka, 2004). Compared to coal, generating electricity from solar photovoltaics significantly reduces the emission of carbon dioxide, sulfur dioxide, nitrogen oxides and particulates (Fthenakis & Bulawka, 2004). Solar photovoltaics do not harbor the high environmental, economic, and social costs of conventional fuel sources (Fthenakis & Bulawka, 2004).

Production of solar photovoltaic modules is growing by about 45% every year (L. R. Brown, 2009). If increases in production continue to grow at this rate, by 2020, total annual solar photovoltaic installations will reach approximately 500 GW and installed capacity will reach 1500 GW (L. R. Brown, 2009).

Solar photovoltaic installation capacity for completed installations in 2009 grew 40% over 2008 (Sherwood, 2010). The installed capacity in the residential sector doubled during that same time period (Sherwood, 2010). Additionally, the photovoltaic installed capacity in the grid-tied utility sector tripled from 2008 to 2009. (See Appendix, Figure A6: Cumulative U.S. Grid-tied Photovoltaic Installations (2000-2009)). This is particularly significant since many of the dangers to wildlife from renewable energy occur as a result of utility scale projects. The
definition of utility scale differs based on technology. (For solar, large, utility scale solar is commonly defined as those projects over one MW in capacity.)

Due to market growth, the cost of solar energy is decreasing in industrialized countries. In 2007, the average peak watt price was $7, including hardware, mounts, wiring and associated electrical systems, and installation. The decreases in price are making renewable energy more comparable to conventional fuel prices. However, this does not mean that conversion to solar photovoltaics instead of conventional fuel sources will automatically occur (L. R. Brown, 2009).

Concentrated Solar Power

Concentrated solar power (CSP) can mean concentrating solar radiation onto a high efficiency solar photovoltaics cell. However CSP usually describes the conversion of sunlight to heat that is used to power turbines and generate electricity (solar thermal) (L. R. Brown, 2009). Solar thermal technologies can be used to heat water in pipes and tubes or concentrate heat onto a specific area that contains a liquid. The heated liquid turns into steam and powers an engine cycle to generate electricity (Luzzi & Lovegrove, 2004). The best resources for CSP in the country are again the Southwest. (See Appendix, Figure A7: Concentrated Solar Power Resource of the United States.)

In 2009, 13.5 MW of concentrated solar power (four systems) were added to the grid in the U.S. (Sherwood, 2010). (See Appendix, Figure A8: Annual Installed U.S. CSP Capacity (1982-2009)). They were located in California, Arizona, and Hawaii. CSP systems, in general, are utility scale and generate electricity on the utility side of the meter and rarely, if ever, as a form of distributed generation (Sherwood, 2010). Several installed plants are used for heat applications for the industrial or commercial sectors. The first CSP plant was completed in 1991.
in California, and was the world’s only utility scale solar thermal plant until another was completed in Nevada in 2007 (L. R. Brown, 2009).

As of 2009, there were about 6.1 GW of solar thermal power plants in development. Each of these plants are under contract with guaranteed long-term power purchasing agreements (PPAs) to decrease risk to investors by ensuring the electricity will be purchased at a set rate (often higher than wholesale market rates) (L. R. Brown, 2009).

Costs of electricity from CSP have been falling, similar to the costs of solar photovoltaics. Currently, solar thermal electricity is approximately twelve to eighteen cents per kilowatt hour (kWh). However, the U.S. Department of Energy has goals to decrease that price to 5-7 cents by the year 2020 through increases in research and development investment (L. R. Brown, 2009).

In the U.S., seven states are considered to have compatible resources for the use of CSP. California, Arizona, New Mexico, Nevada, Colorado, Utah, and Texas make up the 139,601 km² where CSP is well suited (Mehos & Kearney, 2007; U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a). Concentrated solar power systems require approximately 2.3 ha of land per MW of installed capacity, assuming a capacity factor between 25–50% (Mehos & Kearney, 2007; U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a).
Table 2: Ideal CSP Land Area and Resource Potential in Seven Southwestern States

<table>
<thead>
<tr>
<th>State</th>
<th>Available Area (km²)</th>
<th>Resource Potential (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>49,987</td>
<td>2,468</td>
</tr>
<tr>
<td>California</td>
<td>17,871</td>
<td>877</td>
</tr>
<tr>
<td>Colorado</td>
<td>5,439</td>
<td>272</td>
</tr>
<tr>
<td>Nevada</td>
<td>14,504</td>
<td>715</td>
</tr>
<tr>
<td>New Mexico</td>
<td>39,368</td>
<td>1,940</td>
</tr>
<tr>
<td>Texas</td>
<td>3,108</td>
<td>149</td>
</tr>
<tr>
<td>Utah</td>
<td>9,324</td>
<td>456</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>139,601</strong></td>
<td><strong>6,877</strong></td>
</tr>
</tbody>
</table>

Source: Mehos & Kearney, 2007

State Policies that Support Growth in the Renewable Energy Sector

Growth of the renewable energy sector is projected to increase in the future due to several state and federal policies incentivizing their installation and generation. Renewable portfolio standards (RPS) are policies implemented at the state level that require electric power providers to supply a minimum portion of electricity sales from state designated renewable energy resources. These targets are assigned both a quantity or percentage of renewable energy and a deadline in which this quantity or percentage of renewable energy must be met (Union of Concerned Scientists, 2009). The use of RPS policies has been seen as an effective tool for growth in the renewable energy sector (Union of Concerned Scientists, 2009).

This type of policy is market based and spurs competition between renewable energy generators and drives down the costs of renewable energy, allowing developers to increase
production and economies of scale. This allows renewable energy to be more competitive in the energy sector (Union of Concerned Scientists, 2009). Twenty-nine states and the District of Columbia have an RPS. Seven additional states have non-mandated goals (DSIRE: Database of State Incentives for Renewables & Efficiency & Summary Maps, 2011). (See Appendix, Figure A9: RPS Policies). In the Southwestern U.S. (California, Arizona, New Mexico, Nevada, and Utah), each state has an RPS except Utah. However, Utah does have a renewable portfolio goal. Three of those states have minimum solar carve outs within the RPS, which indicate that a certain percentage of renewable energy within the RPS must be solar energy (DSIRE: Database of State Incentives for Renewables & Efficiency & Summary Maps, 2011).

Specifically in the Southern Great Plains (Kansas, Colorado, Oklahoma, and Texas), where wind energy is being extensively developed, each state has an RPS policy except Oklahoma, which, like Utah, has voluntary standards. The utilization of RPS policies has allowed for increased competition and installation of renewable energy in the Southern Great Plains regions, specifically widely available wind energy (DSIRE: Database of State Incentives for Renewables & Efficiency & Summary Maps, 2011).

Federal Policies that Support Growth in the Renewable Energy Sector

Federal support for renewable energy has come about at an unprecedented level allowing for the expansion of renewable energy markets throughout the country.⁷

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⁷ It is important to note that federal financial support for the energy sector has primarily fallen to conventional fossil fuel and nuclear energy. Subsidies for nuclear and conventional fuels outweigh renewable energy subsidies eight to one. In addition, conventional fuel subsidies have accounted for approximately 90% of energy subsidies in the past sixty years (Goldberg, 2000; Sovacool, 2008).
Public Utility Regulatory Policy Act

The Public Utility Regulatory Policy Act (PURPA) was passed in 1978 during what is commonly known as an era of energy crisis. PURPA was enacted for the purpose of energy independence and security, energy efficiency, electricity sector diversification and the promotion of alternative energy (Union of Concerned Scientists, 2010b). It mandates competition in the energy sector, specifically among utilities. As a result of PURPA, a market was created for independent power producers. Utilities were required to purchase power from those independent power producers at the avoided cost if the price from the independent company was lower than the utility’s cost to generate that power themselves (Union of Concerned Scientists, 2010b). This law is credited with the grid connection of non-hydro renewable generation capacity equivalent to over 12 GW (Union of Concerned Scientists, 2010b).


Energy Policy Act of 1992 (EPAct) allowed for exempt wholesale generators (EWGs) to enter and compete with the wholesale electricity generators. On a case by case basis, the U.S. transmission grid was opened up to wholesale suppliers by the Federal Energy Regulatory Commission (FERC) (U.S. Energy Information Administration, 2011). In August of 2005, EPAct was amended to increase domestic energy production and promote renewable energy, conservation, and energy efficiency. It mandated standards for energy efficiency and conservation and provided tax incentives and credits for investment and efficiency improvements (U.S. Energy Information Administration, 2008).

The EPAct also established Clean Renewable Energy Bonds, or CREBS. These bonds allowed the financing of renewable energy projects for non-taxable power providers that are not
eligible for investment tax credits (ITCs) or other tax credits. CREBS allows for the application of a federal income tax credit, instead of paying interest, for those entities that purchase bonds. According to the Department of Energy, these bonds are essentially an interest free loan.

The Renewable Energy Production Incentives were put into place by EPAct to support energy generation facilities. Load serving entities are allocated funds on a per kWh generation basis for the first ten years a qualified facility is in operation (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2007). The amount a facility receives is dependent on the amount of money the program has appropriated to it each year based on the federal budget. Full payments for this program have not been made since 1995 since the federal budget has been insufficient (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a).

*Emergency Economic Stabilization Act of 2008*

**American Recovery and Reinvestment Act**


The ARRA enhanced the ITC system by allowing projects with subsidized energy financing to receive full tax credits (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a). The ARRA also oversees the dispersal and issuance of cash grants instead of ITCs by the U.S. Department of Treasury. This allows for increased financing opportunities for renewable energy development and stimulated the market in a time of economic and financial decline (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a). Also put into place was a manufacturing tax credit (up to 30% of capital investment) for new investments in renewable energy manufacturing.

ARRA expanded the Department of Energy Loan Guarantee Program put into place by EPAct (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a). The CREBS program was allocated $1.6 billion. In total, after the additional ARRA supplement, $2.6 billion was allocated for CREBs (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a). Funds for energy efficiency and the installation and use of renewable energy sources were also appropriated to the Federal Buildings Fund. Overall, the EESA and ARRA accounted for approximately $5.5 billion in funds for green building improvements (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a).
Funds from the ARRA were also allocated to the Department of Energy’s State Energy Program (SEP). About $3.1 billion in funds were distributed to every U.S. state (and territory) energy office in order to support activities such as promotion of new financial mechanisms for the advancement of renewable energy investments, education, energy efficiency, weatherization, energy audits and building retrofits (U.S. Department of Energy, Energy Efficiency & Renewable Energy, 2010a).

The enactment of these policies has led to the increased rates of renewable energy development in the U.S. seen today (L. R. Brown, 2009). Although this is beneficial from the perspective of global climate change, the conflicts from renewable energy with ecosystems and wildlife persist. There is no mention within the renewable energy development policies to safeguard wildlife from negative impacts. The renewable energy sector policies meant to define responsibility for global commons are, in actuality, inadequate under a commons framework from the perspective of wildlife and ecosystem health.
Does Wildlife Policy Work Within a Commodity or Commons Paradigms?

There are additional policy mechanisms which operate under a framework to support wildlife and ecological health. Presently several policies such as the Endangered Species Act and the Migratory Bird Treaty Act exist for exactly this purpose. Similar to renewable energy policy lacking provisions for wildlife protection, wildlife policy does little in the way of protecting wildlife from energy development based threats.

The Endangered Species Act

The Endangered Species Act (ESA) was passed by Congress in 1973 after growing interest in the environmental movement. It is widely viewed as the strongest legal protection for biodiversity (Salzman & Thompson, 2007). It was enacted with the goal of giving endangered species the highest priority by stopping and reversing species extinction, thereby allowing for the protection of species and valuable land associated with their survival, regardless of economic cost. The ESA has authority over public and private ventures, including federal agencies and subsequent federal actions such as construction associated with transportation and other infrastructure as well as land development on public and private property (Salzman & Thompson, 2007). The ESA has been amended seven times since its inception to include revisions on habitat conservation plans, incidental take permits, no surprises policies and safe harbor agreements (Davison et al, 2005).

Administrative responsibilities for this act lie with two federal agencies: The Fish and Wildlife Service (FWS), a division of the Department of the Interior, and The National Marine Fisheries Service (NMFS) in the Department of Commerce. The FWS presides over terrestrial
and avian species as well as freshwater fish. The NMFS manages the responsibilities in regards to marine species (Salzman & Thompson, 2007).

The ESA created two types of categories for species: endangered and threatened. Endangered species are those that are at risk of extinction within most of their habitat. Threatened species are those that are not currently endangered but will likely become so without proper protection in the foreseeable future throughout all or portions of their habitats (Endangered Species Act of 1973.2002). Critical habitat, habitat needed for species survival, is also designated by the FWS when a species is listed (Clarke & McCool, 1996).

Any person, organization, or the FWS themselves can petition the FWS in order to get a species listed. The FWS then is allowed up to 90 days to evaluate whether the person or party’s petition is valid. If it is valid, the FWS has a year to decide whether the species warrants being listed. If it is determined that the species should indeed be listed, a recovery plan is put into place in order to reverse the trend of that species toward extinction. The FWS must also establish whether manmade or natural factors are causing the stresses on those species (Salzman & Thompson, 2007). Reviews are conducted every five years in order to ensure accuracy of listing classifications and status (Clarke & McCool, 1996). Ideally, after being listed as endangered or threatened (Section 4 of the ESA) and a recovery plan put into place, the threat to the species’ success will have been mitigated allowing species and populations to recover to the point that they no longer need to be relisted (D. D. Goble & Freyfogle, 2002).

The range of a threatened or endangered species is considered critical habitat after a species’ federal listing. However, the Secretary of the Interior may exclude portions of a habitat if it is deemed that the benefits of excluding an area outweigh the benefits of designating it as
critical habitat. This exclusion will presumably not be taken if the failure to designate a habitat as critical would surely result in the extinction of the species (Endangered Species Act of 1973.2002; Davison et al, 2005).

**Policy Assessment**

Funding has been an issue plaguing the ESA and its protection capabilities. According to Clarke (1996), at the time of publication, approximately fifty high profile species received over eighty-five percent of total funding while over two-hundred species do not receive funding. Often charismatic species and megafauna are among those that receive the most funding (Salzman & Thompson, 2007). In terms of critical habitat protection, the FWS and NMFS have not been allocated enough resources to manage the complex, expensive, and time-consuming task of respecting and protecting critical land designation (Davison et al, 2005). Many believe that if the ESA is to continue to be effective in preventing species extinction the federal government should better allocate resources and funding to the implementation of the Act as well as to species (Davison et al, 2005).

Once a species is listed as endangered, less than 1% of the more than 1800 species classified have been declared extinct (Davison et al, 2005). However, the ESA is often criticized because it does not offer species protection unless the species is under severe risk of extinction in what Salzman (2007) calls an “emergency room” approach to ecosystem and species protection. As a result, the risk must be great for species to be protected under the ESA. Habitat needed for a species to be preserved and brought back to a healthy balance is often already lost or under extreme development pressure by this point (Salzman & Thompson, 2007). This is supported by Taylor (2005), which reported that after studying cases of species with and without critical
habitat designation or recovery plans, that species with critical habitat were less likely to be declining in number than those without it, regardless of recovery plan. Due to this discovery, suggestions could be made in favor of making critical habitat designations a higher priority (Taylor et al., 2005).

*Take*

The concept of take is first introduced in the ESA in Section 9(a)(1) in 1982, stating that neither a public nor private entity can take a species that is listed as endangered or threatened (D. D. Goble et al., 2006). The ESA defines take as meaning to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or any attempt to engage in any such conduct” (Endangered Species Act of 1973.2002). In many cases, avian, bat or other fatalities of endangered or threatened species, as a result of wind or solar development, could be considered ‘take’ by the ESA.

However, the FWS and NMFS are allowed to issue incidental take permits that allow for the taking of a species if two circumstances are met. First, the taking must be a secondary result of a lawful activity such as land development, and second, there must be a Habitat Conservation Plan (HCP) in place that has been formulated by the incidental take permit applicant. An HCP works to prevent negative impacts to the endangered or threatened species as much as possible and help ensure that the taking of the species will not reduce the likelihood of survival or recovery of that species. If either of these conditions is not met, or the HCP is not deemed strong enough or not funded heavily enough, the permit will not be issued (i.e. *Sierra Club vs. Babbitt*) (Salzman & Thompson, 2007). However, in order for incidental take permits to be effective, impact estimates must be accurately predicted. Issuing permits also may take from three months
up to several years (McKinsey, 2007). Exemptions are considered permanent unless the exemption would be seen to result in the eventual extinction of a species (Foreman, 2002).

It is interesting to note that when the ESA was originally enacted exemptions were not included, and therefore any activity that negatively impacted a federally listed species was prohibited. Amendments have been put into place to allow for exemptions after several cases were brought up to the Supreme Court where species conservation was ruled against, in favor of activities that were economically beneficial (e.g. Tennessee Valley Authority vs. Hill) (Foreman, 2002). These exemptions allow for compromise between stakeholders and promote continued protection of species.

*No Surprises Policy and Safe Harbor Agreements*

Safe Harbor Agreements pursuant of the ESA were put into place to secure and protect landowner’s rights. It encourages these private landowners to enhance or restore their property for the express purpose of returning the land to its original condition for species habitation. In particular, it guarantees that the private landowner is allowed to return the land to its initial condition at a later date without suffering the punishment of violating Section 9 (the take clause) (Salzman & Thompson, 2007). Safe Harbor Agreements were put into place because the ESA had actually been shown to discourage landowners from coming forward with concerns about endangered or threatened species on their property in what is known as the “shoot, shovel, and shut up” or the Three-S Syndrome (Salzman & Thompson, 2007). A No Surprises Policy was also put into place to help ensure financial security of incidental take permit applicants. It guarantees that the Federal Government will pay for any land or actions that may result from unforeseen circumstances after an incidental take permit is issued to an applicant.
Candidate Conservation Agreements

Candidate conservation agreements (CCA) are arranged through the FWS. Local public and private landowners participate in actions to assist in the conservation of species prior to listing with the purpose of trying to prevent federal listing of the species through the ESA. CCAs are often organized directly through local and state governments rather than having public and private landowners work with the FWS. When species are being evaluated for endangered or threatened status, the FWS takes into account what is already being done to aid the species. CCA’s are a proactive way to preserve a species while also mitigating the negative impacts a listing might have on landowners where that species is present. The FWS also allows for what are called “candidate conservation agreements with insurance,” meaning that if a species is eventually listed even though a CCA was in place, the landowners who participated in the CCA for that species are not responsible for more than what was already agreed upon earlier (D. D. Goble et al, 2006).

Migratory Bird Treaty Act

The MBTA was put into place in 1918 as a replacement for the Weeks-McLean Act of 1913 (Lilley & Firestone, 2008). The MBTA prohibits (by any means) kill, capture, take, buy or sell, or transport any of the listed protected birds (or parts) or their eggs (Cornell University Law School). Eight hundred of the approximately one thousand bird species in the U.S. fall under MBTA protection (Lilley & Firestone, 2008).

Any violation of this is considered a criminal offense (Lilley & Firestone, 2008). In addition, a party does not have to be aware that they are violating any laws in order to be prosecuted with a criminal misdemeanor charge, the prosecutable minimum. Although the
purpose of the enactment of the MBTA was primarily to protect these species from overhunting, new issues have appeared which threaten the wellbeing of these species, pollution, habitat degradation, land development, to name a few.

In particular, the MBTA has been called into question in terms of incidental take and wildlife impacts of wind energy development. Deaths of migratory birds, protected by the MBTA, due to wind turbines may be seen as prosecutable under this act. Since the readings of this act vary, what is deemed prosecutable differs from court to court (Lilley & Firestone, 2008). If wind energy developers take the proper steps to help mitigate the effects of the wind turbines, such as proper siting and solicited involvement with the FWS, there is a decreased likelihood that the wind energy developer will be prosecuted for the subsequent harm to these birds (Lilley & Firestone, 2008; U.S. Fish and Wildlife Service, 2003a).

Unintentional violations of the MBTA may result in fines up to $15,000 and six months in prison per violation as a misdemeanor offense (Paul, 2010). In 2010, a federal appeals court found oil field equipment in Kansas, which unintentionally killed three birds in 2007 (two Northern Flickers and an Eastern Bluebird), was liable under the MBTA, affirming violators do not need to have intent to be found accountable (Paul, 2010). Intentional violations may result in fines of between $250,000 and $500,000 and up to two years in prison under felony charges per violation. Although the likelihood of prosecution under the MBTA may decrease when mitigation of impacts are taken into account, these types of actions by developers do not eliminate the legal threat since there is no means for approval of unauthorized take. Any one developer can find itself prosecuted at any time (U.S. Fish and Wildlife Service, 2003a).
The MBTA operates under what is called “selective enforcement” (McKinsey, 2007). Unlike the ESA, civil suits are not allowed when identifying violations of the MBTA. The potential for civil suits, in the case of the ESA, often incentivizes developers to seek incidental take permits. A specific and unique type of take permit is allowed for scientific collecting, national security, and in some instances, falconry (McKinsey, 2007). In addition, the only governmental agency that is tasked with the enforcement of the MBTA is the FWS.

In the same way that renewable energy policy does not account for wildlife protection, wildlife and species based policies do not contend with threats from the renewable energy industry. Wildlife policies also do not work to ensure that the global benefits and positive environmental externalities from renewable energy generation are accounted for, in comparison to the conventional system (Walker & Salt, 2006). There is little room for compromise, outside of ESA exemptions, and creates a framework that supports unidirectional policies. “All or nothing” policies like those exemplified here sustain and serve as the foundation for a paradigm of commodification.
Case Studies

Although renewable energy development fosters a suite of wildlife and ecological impacts, it has the potential to move from its current growth paradigm to one that does not damage and spoil the ecological commons. When renewable energy plays by the rules of the commons there is potential for mitigation or elimination of the conflict between itself, wildlife preservation, and ecosystem health. There is a way to behave in the commons that is ecologically minded and appropriate within that context. Wind and solar energy developers have been shown to give ground to the cause of preservation and have been learning to behave and take advantage of their unique situation in this ecological commons (Ivanpah Solar Electric Generating System (ISEGS), 2010; Oklahoma Gas and Electric Company, 2010b). If renewable energy development can continue to grow and develop in conjunction with wildlife preservation and ecological health ideals, the conflict can be mitigated. The following case studies examine the plight of two species, the Lesser-prairie chicken and the Desert tortoise, as a result of renewable energy development in their habitat. These cases indicate how developers are attempting to work within an ecological commons-based approach.

Wind Energy Development and the Lesser Prairie-Chicken

Prairie grouse, for example the Lesser-prairie chicken (*Tympanuchus pallidicinctus*), prefer grassland habitat which tends to be those areas best suited for wind development (Hagen & Giesen, 2005). Lesser prairie-chickens are listed as Candidate species under the Endangered Species Act (ESA) (U.S. Fish and Wildlife Service, 2010d). They primarily live in Kansas, Colorado, Oklahoma, Texas, and New Mexico. Mate selection takes place on leks where males gather together to display for females in an act called “booming.” After mating, hens lay their
eggs and incubate them within approximately 1–3 km from the original lek site. These grounds are an important component for prairie grouse health and intrusion by nearby wind turbine siting, like habitat fragmentation and noise disturbances, leads to decreased populations and habitat abandonment (Arnett et al, 2007; Flock, 2002). However, the ability for prairie grouse to relocate depends on seasonality as well as alternate habitat and resource availability (Arnett et al, 2007).

![Lesser Prairie-Chicken Habitat Range](image1.png) ![Wind Resource Potential at 80-meters](image2.png)

**Figure 3: Map of Species Habitat for the Lesser Prairie-Chicken (*Tympanuchus pallicicinctus*) versus Wind Resources at 80-Meters**


Candidate species are those for which information suggests that a proposal for the species to be listed as either Endangered or Threatened is warranted, but listing is precluded based on the idea that other species should be given priority (Department of the Interior, Fish and Wildlife Service, 1998). Species identified as being candidates are then given a listing priority number,
one being the highest and twelve being the least priority (U.S. Fish and Wildlife Service, 2010a). Lesser prairie-chickens are listed as priority two (U.S. Fish and Wildlife Service, 2010d).

The increase of human influence has been designated as a threat to the Lesser prairie-chicken. Human influence has primarily caused disturbances to habitat due to habitat conversion, herbicide use, extraction of fossil and mineral based fuels and excessive livestock grazing (Wildlife Habitat Council, Wildlife Habitat Management Institute. National Resources Conservation Services. U.S. Department of Agriculture, 1999). In addition, development of renewable energy, wind energy in particular, has the potential to contribute significantly to the loss of this species due to habitat fragmentation, disruption, and loss (Pruett, Patten, & Wolfe, 2009; U.S. Fish and Wildlife Service, 2010c). It has been documented that Lesser prairie-chickens will readily move across minor barriers in habitat such as roads and fences, but exhibit avoidance of large structures such as buildings and transmission systems. This behavior persists even in areas near and within high quality habitat (Pruett et al, 2009).

Wind development has been rapidly increasing and there is a significant overlap between the best wind resources in the country and the habitat range of the Lesser prairie-chicken. Although collision with wind turbine blades by Lesser prairie-chickens is rare (since they seldom fly higher than six meters), disturbances due to habitat fragmentation and avoidance behaviors caused by tower structure and associated transmission lines have the potential to be substantial (Pruett et al, 2009). This significantly increases threats to the species and indicates that further evaluation and participation in the protection of the species and regulation of energy development and siting must take place at the federal and state level (National Renewable Energy Laboratory, 2010b).
Oklahoma Department of Wildlife Conservation (ODWC) in particular has been spearheading efforts to develop tools and protection for the Lesser prairie-chicken and associated habitat (e.g. the Oklahoma Lesser Prairie Chicken Spatial Planning Tool). This tool works to quantify habitat value within Lesser prairie-chicken range and can be used by developers to determine which areas may pose less detrimental impacts to the species (Oklahoma Office of the Secretary of Environment, 2010). In addition, the tool may be used to identify costs of developing within the Lesser prairie-chicken range as well as determine costs of restoring and recovering habitat where developments have occurred. It is the ODWC’s hope that this planning tool may serve as a guideline for identifying areas of least impact as well as establish voluntary guidelines for habitat restoration due to impacts of development (Oklahoma Office of the Secretary of Environment, 2010).

Oklahoma Gas and Electric Company (OG&E) has been working since 2003 to develop wind energy in its service area. They built Centennial Wind Farm in Harper County in 2006 (which falls within current Lesser prairie-chicken range) that generates 170 MW in capacity. It is one of the largest wind farms in the country and provides enough power to provide for 51,000 homes. In addition, OG&E has stated that they would like to increase their wind power capacity by a factor of four within the next several years (Oklahoma Gas and Electric Company, 2010a). Without taking into consideration the wildlife impacts, OG&E would only be serving to perpetuate the commodity-based paradigm without the potential for mutually beneficial solutions.

However, OG&E has also been working to protect the Lesser prairie-chicken in light of the company’s wind energy development plans. The company works to limit or offset the effects of its wind development on the species in conjunction with ODWC. OG&E has pledged their
involvement to ensure that the Lesser prairie-chicken does not become endangered. In doing so, wind development and growth of the industry can persist, whereas classification of the species as federally endangered would limit wind development potential (Alford, 2011). As of 2010, OG&E granted $3.75 million for Lesser prairie-chicken habitat preservation (Oklahoma Gas and Electric Company, 2010b).

In this same way, individual land-owners work within a commons paradigm by participating in CCAs for the protection of Lesser prairie-chickens. For example, a local rancher in Barbour County Kansas, Theodore Alexander, was issued a CCA. He was issued this in order to promote lesser prairie-chicken conservation while also maintaining his ranching operations on his 2232 acres of land. In order to fulfill the conservation portion of the CCA, he has been restoring his grasslands, participating in prescribed burning, in addition to strategic livestock grazing and alternation of stock watering locations. The agreement also dedicates 10% of his land for habitat while allowing for incidental take of the Lesser prairie-chicken if it ever becomes federally listed under the ESA in the future (U.S. Fish & Wildlife Service & Mountain-Prairie Region, Endangered Species Program).
Solar Power and the Desert Tortoise

Solar energy development has recently come into conflict with portions of the habitat occupied by the federally threatened Desert tortoise (*Gopherus agassizii*) (Defenders of Wildlife, 2011). The Desert tortoise is a terrestrial reptile with a dome-shaped shell, round hind legs, and heavily scaled and flattened front legs for digging (U.S. Fish and Wildlife Service, 2010b). These tortoises spend approximately 95% percent of their lifetimes burrowing to avoid extreme hot and cold temperatures. They have low reproductive rates, are susceptible to drought, and are preyed on by ravens and coyotes (Leitner, 2009). Each adult tortoise requires approximately 40.5 ha of habitat and is susceptible to habitat disruption by potential concentrated solar power developments. The Desert tortoise currently inhabits areas of Arizona, California, Nevada, New Mexico, and Utah, primarily within the Mojave Desert (U.S. Fish and Wildlife Service, 2010b).
The tortoise has been given the classification of Threatened under the ESA since 1990. This applies to all regions where the Desert tortoise is found except for those within the Sonoran Desert in Arizona. Threatened status allows many of the same protections that are in place for species that are classified as endangered, and the protections for threatened species are unique to their recovery needs (U.S. Fish and Wildlife Service, 2003b).

BrightSource Energy is in the process of constructing a two billion dollar solar thermal power plant, called the Ivanpah Solar Electric Generating System (ISEGS) (Ivanpah Solar Electric Generating System (ISEGS), 2010). This project is located on 1,457 ha of public land managed by the BLM in California (Bureau of Land Management, 2010). It is projected to be a 392 MW system and is the largest solar thermal project permitted in 20 years. It is also expected
to be the largest system (both in capacity and land use) of this kind in the world. It will be comprised of three plants (fields of solar tracking heliostat mirrors that reflect solar radiation onto boilers of central power towers) built between 2010–2013 and will generate enough electricity to serve 140,000 California homes during peak hours (Bureau of Land Management, 2010; Ivanpah Solar Electric Generating System (ISEGS), 2010). To supplement heat for the startup of boilers due to the intermittent nature of solar, a natural gas pipeline with a natural gas-fired start-up boiler will be extended through the site (Bureau of Land Management, 2010).

BrightSource highlights the economic and environmental benefits of their solar thermal project. One-thousand jobs are expected by be created at peak construction with 650 on an average over a 3 year period, including millions of revenue in construction wages, employee earnings and state and local tax revenue. In addition, BrightSource estimates that 13.5 million tons of carbon dioxide emissions will be avoided over the 30 year life cycle of the plant, and emphasize their low-environmental impact technologies (Bureau of Land Management, 2010; Ivanpah Solar Electric Generating System (ISEGS), 2010).

An Environmental Impact Statement (EIS) was conducted of the potential environmental and public health and safety impacts by the system under the National Environmental Policy Act (NEPA) (Bureau of Land Management, 2010). Alternatives to the specific technologies and sites were conducted, however, the use of alternatives would not significantly improve the projected impacts to the environment at a similar generation scale as the CSP plant provides, and in many cases, fossil fuel development in that region could increase detrimental impacts (Bureau of Land Management, 2010). It was also determined that energy conservation and efficiency would not be sufficient to meet the growing energy demands in that region and those actions would also not
contribute to the RPS requirements in that state, further contributing to the commodification and growth of renewable energy (Bureau of Land Management, 2010).

This area of land, under management of the BLM, is inhabited by the threatened Desert tortoise and other potentially threatened species like the Mojave ground squirrel, and additionally will impact breeding and/or foraging habitat for other species including but not limited to the burrowing owl, golden eagle, and American Badger (Woody, 2010). The footprint of this solar thermal project is unprecedented and can impact the fragile desert ecosystem and already stressed species. The total project footprint is approximately 4,073 acres (6.4 square miles), with the facilities themselves occupying about 3,670 acres and the remainder used for transmission, substations, and construction staging (Bureau of Land Management, 2010). This footprint has the potential to foster the growth of invasive plant species and increase Desert tortoise predators (like ravens) due to increased habitat fragmentation and degradation (Bureau of Land Management, 2010).

The Desert tortoise is setting the pace for the development of this land. Since the Desert tortoise is federally listed species, formal consultation with the FWS was needed to create and issue a Biological Opinion to review and identify mitigation measure to protect the tortoise. Although environmental organizations have suggested that companies like BrightSource focus on land that has already been disturbed, BrightSource has used this opportunity to evaluate impacts on the tortoise on the previously acquired land (Ivanpah Solar Electric Generating System (ISEGS), 2010; Woody, 2010).

Disturbances to the land will be minimized as much as possible. A relocation site, ~1.6 km from the tortoises’ current habitat, has been approved for the transfer of 38 animals. Desert
tortoises within the construction zone are given health exams and fitted with radio transmitters to keep track of the tortoises during the process. They are temporarily housed in holding pens with artificial burrows set up in the area before they are moved to what is hoped to become a permanent reserve location in the spring of 2011. BrightSource has agreed to monitor the health and wellbeing of the population of tortoises moved to the relocation site for 3 years, allowing for the potential to gather additional information on the desert tortoise (Ivanpah Solar Electric Generating System (ISEGS), 2010; Woody, 2010).

When BrightSource, and the Ivanpah project in particular, put the health of the desert ecosystem and the species that inhabit it at the forefront, they are operating under a commons paradigm. Although an argument can be made that the efforts made by BrightSource are not substantial enough to protect habitat and allow for the cultivation of viable populations, they are making a marked advancement in working towards the utilization of the commons framework. This allows renewable energy to work under the wider lens of climate benefits while also accommodating a commons-based paradigm which fosters responsibility for ecological health and the environment.
Policy Failures and Inadequacies

As the case studies indicate, there are ways in which renewable energy developers and wildlife policy can work together to promote commons ideals. The ability and occurrence of cooperation for this purpose has been inadequately addressed by the renewable energy and wildlife policies. This does not suggest that renewable energy is equivalent to conventional energy sources as that is not true since conventional fuel sources do host a myriad of environmental problems. These include but not limited to those related climate change, poor air and water quality, and ecosystem destruction (Arnett et al, 2007; Asner et al, 2010; Bernie et al, 2010; Boyce et al, 2010; Ehrlich, 1994; Forster et al, 2007; Intergovernmental Panel on Climate Change, 2007a; Millennium Ecosystem Assessment (Program), 2005; Rahmstorf et al, 2007; Solomon et al, 2009; Tilman, 2000; Totten et al, 2003; Webster et al, 2009). The purpose of this research is to promote renewable energy as a preferred source of energy generation that also supports commons ideals.

Although the ESA has weaknesses, the general ESA framework allows for wildlife protection and compromise with developers through the use of exemptions for compliance with the Act. These exemptions have the potential to be taken advantage of more frequently and are the portion of the Act that supports and works within a commons paradigm (D. D. Goble & Freyfogle, 2002; Salzman & Thompson, 2007). As a result of the exemptions, ESA has the potential to serve as the bridge between renewable energy developers and restrictive wildlife conservation practices to create a value-based system that supports mutual goals. Whenever stakeholders are taking advantage of the incidental take permits and habitat conservation plans, collaboration towards a commons paradigm is occurring.
Since there are no exemptions or incidental take permits within the MBTA, unlike the ESA, it is difficult for developers to come to mutual agreements with wildlife conservation entities for the benefit of the global and ecological commons (Lilley & Firestone, 2008). In very rare circumstances, such as those which are matters of scientific study and national security, permits may be granted by the FWS for the destruction of species or their habitats (Contemporary practice of the United States: International Environmental Law.2003; Lilley & Firestone, 2008).

Renewable energy development and associated policy is lacking in commons thought in a similar way. The MBTA is focused on strict migratory bird protection without exception. Renewable energy policy is focused on a paradigm of growth and development without exception. As depicted previously, there are no signals within current U.S. energy policy to value the ecological commons, although renewable energy is operating within an ecological world. Renewable energy policies in the U.S. focus on propelling growth within the industry for the good of the global commons, and do not take biodiversity preservation into account (L. R. Brown, 2009). Therefore, although the renewable energy industry has been touted as being environmentally benign and the key to solving problems within the global commons, it fails to establish itself and behave within an ecological commons perspective.

Table 3 below illustrates the designation of the wildlife and renewable energy policies within the originally proposed matrix. Target box for action is cell I where renewable energy is evaluated based on commons ideals and impacts to wildlife and where wildlife policy allows for compromise. This means that renewable energy policy has been reformed from its current practices which enable conflicts. Current practices and policies oscillate between cells II, III, and
IV where renewable energy policy and development or wildlife policy or both maintain commodity paradigm characteristics.

Table 3. Post Examination Paradigm Designation Matrix

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<tr>
<th>POLICY</th>
<th>COMMONS</th>
<th>COMMODITY</th>
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<tr>
<td>Commons</td>
<td>I Renewable Energy Reformed paired with</td>
<td>II Renewable Energy Unreformed paired with</td>
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<td></td>
<td>ESA Policy with mechanisms for compromise</td>
<td>ESA with policy mechanism for compromise</td>
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<td></td>
<td>MBTA Policy with improvements</td>
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<tr>
<td>Commodity</td>
<td>III Renewable Energy Reformed paired with</td>
<td>IV No concern for commons i.e. No renewable</td>
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<td>MBTA with all or nothing policies</td>
<td>energy paired with</td>
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<td></td>
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<td>Only species with human utility perpetuated</td>
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<tr>
<td></td>
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<td>with all or nothing policy</td>
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<tr>
<td></td>
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<td>framework similar to MBTA</td>
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</table>

The case can be made that renewable energy should be the exception to acting in the ecological commons due to its big-picture, global climate benefits (Murray, 2011). However, by making that case, renewable energy is an active participant in the commodity paradigm, creating conflicts with ecosystems and wildlife (Arnett et al, 2007; Byrne et al, 2002; Fthenakis & Bulawka, 2004; Toly, 2004). Growth in the renewable energy industry has been given a free ride by taking advantage of the ecological commons since it (specifically wind and solar power) has been deemed successful due to their wider climate health (global commons) benefits. When the renewable energy industry does not value the ecological commons, as indicated by the previous
wildlife impacts, it is behaving in a similar fashion to every other threat to equity, climate, and ecosystem health.

Renewable energy can be identified as a source of misuse of the commons, and even a misuse of property rights, negating Hardin’s framework where privatization and property rights were the best way to manage the biological commons (Hardin, 2005). When renewable energy development serves under the commodity paradigm, it becomes a beacon of the irresponsibility towards the ecological commons. It can be directly seen in the development of land for the express purpose of renewable energy projects, while taking land that is valuable for ecosystem processes and wildlife without regard to conservation practices and species needs. This utilization of land assumes a tradeoff situation; either renewable energy development wins, or the wildlife and associated preservation wins. Under this framework, the conflict between wildlife and renewable energy does not get resolved.

As proposed by Herman Daly, a steady state renewable energy economy is needed. To clarify, the oxymoron of “sustainable growth” is true for renewable energy and it is not immune because of its potential global climate benefits (Daly, 1991). Society as a whole needs to move away from viewing renewable energy as being successful in a state of steady growth and needs to shift into an alternate perspective that does not undervalue the commons. Renewable energy is in a unique place to work within a commons framework due to its global climate benefits, rather than it being in a situation in which to exploit and manipulate the energy industry and ecosystem health due to those same benefits under a commodity framework.

Compromise between a strict conservation mindset and an unrelenting development approach is needed to propel forward into a commons-based paradigm of growth. The exemptions found within the ESA are an example of this type of compromise and there is
potential for additional wildlife conservation and energy policies to function under that same premise.
**Recommendations**

Renewable energy and wildlife policies must operate under a commons paradigm in order to mitigate commons-based problems. A new policy approach is needed that defines how to govern utilization of the commons. Ecological and sustainable ideals should become customary. Rules should be written that begin with the commons framework, keeping wildlife conservation and ecosystem health at the forefront and recognizing the limited nature of the commons (Byrne & Glover, 2002; Byrne et al, 2002; Costanza et al, 1997). Until such policies are put into place, renewable energy and wildlife conservation and ecosystem health will continue to be measured inadequately and thus undervalued in the current economic system.

**Policy Recommendations**

A framework of policies should be created which facilitates the establishment of mutually beneficial solutions for both wildlife and renewable energy under a commons-based paradigm.

There are ways to improve wildlife policies already in place to ensure the paradigm in use is commons oriented. Since the ESA exemptions are in the form of voluntary filings of incidental take permits, it may be beneficial to adjust the ESA policy to promote further voluntary conservation agreements. This may be possible through increased promotion at the state and local level, increased communication, and increased regulation funding.

The MBTA does not have exemptions and as a result, there is a possibility for change and expansion to take advantage of a shift to a commons paradigm. Consideration of exemptions under the MBTA could allow for thorough compliance since without exemptions it is nearly impossible to comply under current statutes. However, one cannot merely suggest that every potential “take” of a migratory bird be paired with a permit since anything from installation of
picture windows to agriculture and energy infrastructure development would have to be included (Means, 1998). Although that option is unrealistic, the MBTA certainly could be augmented to allow for mutually beneficial policy exemptions for the development and advancement of commons-based practices.

In the same way, renewable energy policy should make wildlife policy, conservation, and ecosystem health a priority. This would require that current and future renewable energy policies include stipulations such as environmental impact assessments and regulate siting and permitting for development (Defenders of Wildlife, 2011). A permitting infrastructure would need to be created specifically for compliance with wildlife portions of renewable energy policy. For example, states could use policies like the RPS to help mandate consideration for the impact of renewable energy development on habitats and wildlife (Arnett et al, 2007). RPS policies could also mandate distributed generation carve outs within an RPS to strengthen support for non-utility scale renewable energy development.

Since renewable energy is advertised as being more sustainable than conventional fuel systems, the sector should support stricter policies on ecosystem health and wildlife conservation. Those strict environmental policies will disadvantage the worst environmental health offenders in the short- and long-term and give renewable energy a competitive advantage over conventional fuel systems.

At a species level, it is highly recommended that federal protection policies be put into place for non-ESA species. For example, bats are particularly susceptible to wind energy development and policies for their protection do not exist outside of the ESA. Protection policies at the federal level for all bat species, not just those that are endangered, should be enacted as soon as possible.
Reducing Impacts to Wildlife and Ecosystems

Although siting of renewable energy projects for the purposes of wildlife preservation has improved over time, there is still room for progress. Siting in areas that are already disturbed allows for minimal negative impacts on biodiversity (McDonald et al., 2009). Vulnerability assessments of the ecosystem should be conducted to identify habitats, species, and biodiversity value in order to minimize impacts (Conservation International, 2011a; Totten et al., 2010).

The permitting process for large scale utilities should not be hastily conducted for the purposes of climate change mitigation at the expense of ecosystem health as it will create further conflicts in the long-term (Kofoed-Wiuff, Sandholt, & Marcus-Moller, 2009). Spatial planning should be utilized to ensure that high-risk areas should also be avoided, such as those identified by the ESA as critical habitat or those that fall under HCPs.

Habitat fragmentation should also be lessened to the greatest extent possible. Areas surrounding critical habitat should be avoided to increase the potential range of species while also limiting the amount of fragmentation and disturbance to habitat. By siting renewable energy development projects in areas that are already fragmented or disturbed, and using existing infrastructure, such as roads, whenever possible, damage to functional, healthy ecosystems and habitats can be mitigated (Arnett et al., 2007).

Strategies should be put into place to help mitigate the impacts that are already occurring and to assist species in coping and adjusting to changes in their habitat caused by renewable energy development; potential approaches include integrated landscape management plans, habitat connectivity assurance, and habitat restoration (Conservation International, 2011a). Plans for the
restoration of disturbed habitat should be considered post-construction in all circumstances, and monitoring the status of habitat and species health throughout the development process should be considered a priority (Arnett et al, 2007; Lilley & Firestone, 2008). This could be supported through improved connections, relationships, and communication among environmental contractors, ecosystem biologists, and policy makers.

Communication

Communication of compliance mechanisms to developers and landowners could potentially facilitate greater compliance. Mechanisms such as CCAs are a way in which to facilitate shared benefits to developers, landowners, and wildlife (D. D. Goble et al, 2006). Habitat and species management information should also be disseminated to stakeholders to improve understanding of the issues at hand. Education about the wildlife on landowner property as well as the existence of compliance mechanisms will no doubt increase the gains to all stakeholders.

Increase Funding

Increased funding should be designated to the permitting and regulating authorities of the FWS and NMFS. Increased funding should go to support the protection of endangered, threatened, and candidate species, and should be allocated to increase staff for the purpose of filing incidental take permits, federally listing species, and enforcement of wildlife policies. Funding should be assigned for the purposes of enhancing communication mechanisms for stakeholders.

Research and development funding should be increased for several purposes. Increased federal monies should be distributed to research scientists to study the impacts of renewable energy development on ecosystems in addition to the research needed to create habitat restoration and species adaptation and coping mechanisms. Funding should also be allotted to the
development of low-habitat impact renewable energy projects and to implement mitigation
techniques to address negative impacts to habitat and wildlife. In addition, funding should be
allocated to the development of distributed generation technologies to lessen the impacts created
by large, utility scale deployment of renewable energy.

Lastly, one of the best ways to decrease the impact on biological systems is to use less energy
and use energy more efficiently (Mittermeier et al, 2008). This should be considered an area for
further study as decreasing energy demand and obesity may lead to decreased conflicts with
natural systems.

These policies and recommendations facilitate changes in approach and eliminate the conflict
between renewable energy and wildlife and ecosystem health. There is a way in which renewable
energy can behave within a commons framework to allow the world to reap its expansive
environmental benefits at all levels, not solely those affiliated with global climate change.
Wildlife policy and renewable energy policy both have the capability to give ground to
conservation and environmental health through the use of a commons paradigm, while working
to create mutually beneficial solutions to commons-based problems.
Appendix 1
Figure A1: IPCC, Changes in Physical and Biological Systems and Surface Temperature 1970-2004

(Intergovernmental Panel on Climate Change, 2007a)
Figure A2: Current Installed Wind Power Capacity (MW)

Figure A3: 80-Meter Wind Map and Wind Resource Potential


Figure A4: Number of Annual U.S. Solar Installations by Technology (2000-2009)

(Sherwood, 2010)
Figure A5: Photovoltaic Solar Resource of the United States

(National Renewable Energy Laboratory, 2010c)

Figure A6: Cumulative U.S. Grid-tied Photovoltaic Installation (2000-2009)

(Sherwood, 2010)
Figure A7: Concentrating Solar Resource of the United States

(National Renewable Energy Laboratory, 2010a)
Figure A8: Annual Installed U.S. CSP Capacity (1982-2009)

(Sherwood, 2010) p. 13

Figure A9: RPS Policies in the U.S.

RPS Policies
www.dsireusa.org / April 2011

(DSIRE: Database of State Incentives for Renewables & Efficiency & Summary Maps, 2011)
Appendix 2
## Wildlife Impacts in the U.S. from Solar PV, Solar CSP, and Wind Energy Generation Technologies

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Generation Type</th>
<th>Impacts-Direct</th>
<th>Impact-Indirect</th>
<th>Source</th>
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<tr>
<td>Blackburian Warblers</td>
<td><em>Dendroica fusca</em></td>
<td>Wind</td>
<td></td>
<td>Habitat Disruption; Positive Edge Impacts</td>
<td>(Hagan &amp; Meehan, 2002)</td>
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<tr>
<td>Bobolink</td>
<td><em>Dolichonyx oryzivorus</em></td>
<td>Wind</td>
<td></td>
<td>Collision</td>
<td>(Kerlinger &amp; Dowdell, 2003)</td>
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<td>Brazilian free-tailed bats</td>
<td><em>Tadarida brasiliensis</em></td>
<td>Wind</td>
<td></td>
<td>Collision</td>
<td>(Kerlinger et al, 2006; Piorkowski, 2006)</td>
</tr>
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<td>Brown Thrasher</td>
<td><em>Toxostoma rufum</em></td>
<td>Wind</td>
<td></td>
<td>Habitat Disruption; Positive Edge Impacts</td>
<td>(National Research Council, 2007)</td>
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<td>Cerulean warbler</td>
<td><em>Dendroica cerulean</em></td>
<td>Wind</td>
<td></td>
<td>Habitat Disruption; Positive Edge Impacts</td>
<td>(U.S. Fish and Wildlife Service, 2002)</td>
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<tr>
<td>Coots</td>
<td><em>VARIOUS</em></td>
<td>Wind</td>
<td></td>
<td>Collision</td>
<td>(National Research Council, 2007)</td>
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<td>Corvids (Crows, Magpies, Ravens, etc.)</td>
<td><em>Family: Corvidae</em></td>
<td>Wind; CSP</td>
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<td>Increased Scavenging Potential</td>
<td>(Bureau of Land Management, 2010; Erickson et al, 2004; Kunz, Arnett, Cooper, Erickson, Larkin et al, 2007; Smallwood &amp; Thelander, 2004)</td>
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<td>Crissal thrasher</td>
<td><em>Toxostoma crissale</em></td>
<td>CSP</td>
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<td>Habitat Disruption</td>
<td>(Bureau of Land Management, 2010; Erickson et al, 2004; Kunz, Arnett, Cooper, Erickson, Larkin et al, 2007; Smallwood &amp; Thelander, 2004)</td>
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<tr>
<td>Species</td>
<td>Scientific Name</td>
<td>Impact</td>
<td>Description</td>
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<td>Dickcissel</td>
<td><em>Spiza Americana</em></td>
<td>Wind</td>
<td>Habitat Disruption</td>
<td>(Pruett et al, 2009)</td>
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<td>Doves</td>
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<td>Wind</td>
<td>Collision</td>
<td>(National Research Council, 2007)</td>
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<td>Eastern Pipistrelles</td>
<td><em>Pipistrellus subflavus</em></td>
<td>Wind</td>
<td>Collision</td>
<td>(Kerns et al, 2005)</td>
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<td>Eastern Towhee</td>
<td><em>Pipilo erythrophthalmus</em></td>
<td>Wind</td>
<td>Habitat Disruption; Positive Edge Impacts</td>
<td>(Bell &amp; Whitmore, 1997; J. P. Duguay, Wood, &amp; Miller, 2000; J. P. Duguay, Wood, &amp; Nichols, 2001; J. P. Duguay)</td>
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<td>Galliformes</td>
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<td>Wind</td>
<td>Collision</td>
<td>(Erickson et al, 2001)</td>
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<td>Grasshopper Sparrows</td>
<td><em>Ammodramus savannarum</em></td>
<td>Wind</td>
<td>Habitat disruption</td>
<td>(Erickson et al, 2004)</td>
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<tr>
<td>Grassland Birds</td>
<td><em>VARIOUS</em></td>
<td>Wind</td>
<td>Habitat Disruption</td>
<td>(Arnett et al, 2007)</td>
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<tr>
<td>Greater Prairie-Chicken</td>
<td><em>Tympanuchus cupido</em></td>
<td>Wind</td>
<td>Habitat and Lek disruption, including barrier avoidance</td>
<td>(Flock, 2002; National Research Council, 2007; Pruett et al, 2009)</td>
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<td>Greater Sage-Grouse</td>
<td><em>Centrocercus urophasianus</em></td>
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<td>Habitat and Lek disruption, including barrier avoidance</td>
<td>(Flock, 2002; National Research Council, 2007; Pruett et al, 2009)</td>
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<td>Gunnison’s sage-grouse</td>
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<tr>
<td>Horned Lark</td>
<td><em>Eremophila alpestris</em></td>
<td>Wind</td>
<td>Collision</td>
<td>(Kerlinger &amp; Dowdell, 2003)</td>
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<tr>
<td>Indigo Bunting</td>
<td><em>Passerina cyanea</em></td>
<td>Wind</td>
<td>Habitat Disruption; Positive Edge</td>
<td>(Sauer, Hines, &amp; Fallon, 2005)</td>
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<tr>
<td>Species</td>
<td>Scientific Name</td>
<td>Impacts</td>
<td>References</td>
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<td>Kentucky Warblers</td>
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<td>Habitat Disruption</td>
<td>(G. D. Johnson et al, 2000)</td>
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**RAPTORS**

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<th>American Kestrels</th>
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<td>Buteo swainsoni</td>
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<td>Nesting Behavioral Changes</td>
<td>(G. D. Johnson, Erickson,</td>
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<td>BATS</td>
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<td>Seminole Bat</td>
<td><em>Lasiurus seminolus</em></td>
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<td>(Kunz, Arnett, Cooper, Erickson, Johnson et al, 2007; National Research Council, 2007)</td>
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<td>Western Red Bats</td>
<td><em>Lasiurus blossevillii</em></td>
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<td>(Kerlinger et al, 2006; Kunz, Arnett, Cooper, Erickson, Johnson et al, 2007; National Research Council, 2007)</td>
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<td>Allegheny Woodrat</td>
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<td>American Badger</td>
<td><em>Taxidea taxus</em></td>
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<td>Habitat disruption</td>
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<td>Beaver</td>
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<td>California Ground Squirrel</td>
<td><em>Spermophilus beecheyi</em></td>
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<td>Employment of Anti-Predator Behavior; Behavioral Modifications</td>
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<td>Coyotes</td>
<td><em>Canis latrans</em></td>
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<td>(Kunz, Arnett, Cooper, Erickson, Johnson et al, 2007)</td>
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<td>Fisher</td>
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<td><em>Equus africanus asinus</em></td>
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Cassandra L. Brunette
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<td>Wild Horse</td>
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<td>Skunks</td>
<td><em>Mephitis mephitis</em></td>
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<td>Small Mammals</td>
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<td>(Merriam, Kozakiewicz, Tsuchiya, &amp; Hawley, 1989; National Research Council, 2007)</td>
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**REPTILES**

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<td>Black Rat Snakes</td>
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<td>Timber Rattlesnake</td>
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**AMPHIBIANS**

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<td>(Knapp, Haas, Harpole, &amp; Kirkpatrick, 2003; Petranka, Eldridge, &amp; Haley, 1993)</td>
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