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Utility Right of Way Management: Potential for Expanded Integrated Vegetation Managment in California

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Abstract:

Utility companies have the challenge of meeting vegetation clearance requirements within their right of ways and complying with various environmental laws and company goals. Vegetation management programs at the major utility companies cost millions of dollars a year. Reducing cost and increasing compliance are goals of right of way managers at utilities across the country. This paper looks at the possibility of increasing the utilization of integrated vegetation management on California's utility right of ways. This paper will examine the current vegetation management strategy of California's major utility companies and determine whether a more comprehensive integrated vegetation management program could be adopted. Examples of the utilization of integrated vegetation management and research at other utilities were examined for reference. The research found that a comprehensive integrated vegetation management program can reduce costs and increase compliance for California's utilities. In addition, integrated vegetation management programs can offer unique opportunities to meet company environmental goals and obligations. These findings lead to several policy recommendations for California utility companies and regulators.

Acronyms:

FERC: Federal Energy Regulatory Commission
NERC: North American Electrical Reliability Corporation
CPUC: California Public Utilities Commission
EEI: Edison Electrical Institute
ESA: Endangered Species Act
PG&E: Pacific Gas and Electric Company
SDG&E: San Diego Gas and Electric
SCE: Southern California Edison
ANSI: American National Standards Institute
EPA: Environmental Protection Agency
HCP: Habitat Conservation Plan
IVM: Integrated Vegetation Management
TVMP: Transmission Vegetation Management Plan
CEQA: California Environmental Quality Act
USFWS: United States Fish and Wildlife Service
ROW: Right of Way
kV: kilovolt
HOA: Homeowner's Association
CEC: California Energy Commission
PRC: Public Resource Code
GO: General Order
SAIFI: System Average Interruption Frequency
SAIDI: System Average Interruption Duration
MAIFI: Momentary Average Interruption Frequency Index
KBB: Karner Blue Butterfly
ITP: Incidental Take Permit
NYSDEC: New York State Department of Environmental Conservation
GRI: Global Reporting Initiative
CNPS: California Native Plant Society

Introduction:

This paper will focus on integrated vegetation management of utility rights of way in California. The paper will discuss the vegetation management programs of the three largest utility companies in California. There will be a discussion of costs and benefits of the current practices and a discussion of methods to improve the management strategies. There will also be a discussion of integrated vegetation management case studies and examples of successful use of integrated vegetation management by other utility companies in the United States. Finally, the paper will conclude with policy recommendations for California's utilities.

Overview:

Gas and Electric utilities are responsible for managing thousands of miles of utility lines throughout the state of California. The gas and electric facilities are generally located within utility held easements, also known as the right of way (PSC, 2013). Easements allow utility companies to locate their facilities and also manage the land within the facilities as needed. The type of land management typically discussed that pertains to utility companies is vegetation management. Vegetation management involves the survey, trimming, and removal of incompatible vegetation within the right of way. Over the last 50 years, the strategies of vegetation management have changed substantially. Manual, repeat removals have been replaced by the selective use of herbicides and integrated vegetation management (Haugen, 2013). As the vegetation strategies have evolved, so have the regulations surrounding management of right of ways. Regulations that were once only self-reporting are now mandatory with considerable penalties for non-compliance (NERC, 2009).

Integrated vegetation management is an ecosystem based approach to utility right of way vegetation management. The focus of integrated vegetation management is on converting incompatible vegetation structures, such as trees or other fast growing vegetation to stable and low growing herbaceous plant communities (EPA, 2012). This vegetation conversion provides the company with some assurances around vegetation related compliance, and offers cost savings in the long-term (Finley Engineering, 2010). Integrated vegetation management is also the American National Standards Institute (ANSI) recognized approach to utility vegetation management, and has been adopted by most utilities in the country (ANSI, 2013).

In addition to the compliance and cost benefits integrated vegetation management provides to the utility company, research has also shown that implementation of IVM offers measurable benefits to native plant and animal species. Studies of plant diversity within utility right of ways managed with integrated vegetation management have shown that these right of ways have greater diversity than those that were managed with other methods (Yahner, 2008). Studies have also found that integrated vegetation management has a positive effect on pollinators, specifically butterflies (Forrester, 2005).

The beneficial effects of integrated vegetation management on plant and animal communities can transfer to long-term resource management strategies for the utility company and resource agencies. Large scale resource permits, such as Habitat Conservation Plans (HCP) can incorporate integrated vegetation management, leading to streamlined permitting and enhanced compliance (Chazen Engineering, 2012). These vegetation management and permitting strategies can also be applied to recently reclaimed right of ways, such as gas transmission right of ways.

This paper will focus on an evaluation of the current vegetation management strategies of the three largest utility companies in California a discussion of how these strategies compare with the requirements of integrated vegetation management. The companies' vegetation management programs will be evaluated and discussed in detail. Federal and state vegetation related regulations will be examined and their enforcement and non-compliance implications discussed. The companies' electrical reliability as well as compliance with federal and state regulations will be reviewed. Case studies of applied integrated vegetation management will be reviewed and successful attributes will be considered for integration into California's utilities. The paper will conclude with policy recommendations for regulators as well as recommendations that utilities can implement in their current vegetation management programs.

Chapter 1. Utility Right of Ways

Right of ways are easements held by utility companies on which the facilities are located (Public Service Commission, 2013). The focus of this paper is on transmission right of ways for both gas and electric facilities. Transmission lines run for miles and can cross state lines, so a utility company must have a means by which to hold land in order to locate and service their

facilities. Easements are a common method. Utility easements are typically a pre-defined, narrow (typically around 100' wide) strip running through a privately held parcel (Public Service Commission, 2013). The property owner maintains ownership of the easement, but has access and use limitations imposed on them by the utility company (Public Service Commission, 2013). Typical land use restrictions include no planting of trees (specifically tall growing varieties) within the easement and no installation of permanent facilities (buildings, concrete pads, etc.) within the easement (PG&E, 2014). The purpose of these restrictions is to allow the utility easy access to their facilities and to maintain the integrity of those facilities. As a result of the San Bruno gas pipeline incident, in recent years in California, there has been a renewed effort to enforce existing land rights within utility rights of ways. This effort will be discussed in more depth in a following section. The utility company pays a one-time fee to the property owner for the easement. The utility company draws up the easement document and agrees on a fee with the property owner (Public Service Commission, 2013). Once the document has been signed, the property owner maintains ownership of the land, and continues to pay property taxes on it, but the utility has the land rights needed in order to install and maintain its facilities (PSC, 2013). Language can be added to the easement document to include adjacent land rights (the company may use land surrounding the easement for staging or laydown), ingress and egress (the company has the right to access their easement through the private property), and other rights such as a right to install gates or remove vegetation. If the easement is obtained for electrical facilities, the utility may not use the easement for gas projects and vice versa.

Another method of property ownership for utility companies is to purchase the land outright; this is referred to as owning land "in fee". Owning the property outright allows the utility to locate their facilities as well as assume control over all aspects of the lands management (PSC, 2011- confirm). Facilities can utilize this land for mitigation or restoration, as discussed more in depth in case studies chapter. Ownership of land in which facilities are located would require the utility company to pay property taxes on the land and would typically cost more than obtaining an easement. A utility company must balance the costs and benefits when determining a land rights/land management strategy.

1.1 Transmission and Distribution Systems

Electrical transmission lines are the power lines that transfer electricity from its generation point (power plant) to a substation for local distribution (Public Service Commission, 2013). Transmission lines can be interconnected and run between state lines and are known as the transmission grid. Common transmission voltages are 60, 230, and 500 kV. The transmission voltages are reduced down to distribution voltages within the substations through transformers (Public Service Commission, 2013). Distribution power lines are the power lines that are used to deliver electricity to residential customers (PSC, 2013). Distribution voltages are typically 12 or 21 kV (PG&E, 2014). From the distribution lines electricity is once again reduced in voltage through transformers and run into houses. Utility companies maintain easements for all of their facilities and must maintain them in such a way as to ensure safe and reliable electricity. Because of their high voltages the regulatory agencies require that transmission facilities have large easement clearances (NERC, 2009). The regulatory requirements for clearance will be discussed in detail in a later chapter.

Gas pipelines are also separated into transmission and distribution networks. Transmission gas lines are large diameter pipes that run at high pressures (PG&E, 2014). Transmission lines are used to bring natural gas from out of state sources and move large quantities of gas long distances between urban hubs. Unlike electric transmission facilities there are few laws that require or regulate clearances around transmission pipelines. Similarly to electric facilities, distribution gas lines are used to deliver gas from transmission pressures and volumes, down to pressures and volumes that can be run into residences. The distribution system consists of pipes that are smaller in diameter and hold a smaller volume of natural gas. The distribution network runs throughout cities and towns and delivers gas for home use.

1.2 Need for Vegetation Management within the Utility Right of Way

Utilities have always had an interest in maintaining vegetation within their right of ways. Conflicts arise between vegetation and high voltage lines when vegetation in left to take over the right of way. Trees and other vegetation that can reach the power lines can lead to outages, caused by short circuiting the power lines (FERC, 2013). Depending on the location of the short

circuit, this could cause many homes to lose power. Direct contact is not always needed to cause an issue, if vegetation gets too close to the power line arcing can sometimes occur. Arcing is when electrical current is able to jump a gap (FERC, 2013). The electricity normally runs smoothly through the power line, but if an object gets too close to that wire, the electricity can jump off the wire and into the tree, person, etc. to ground. The potential for arcing helps to inform the minimum clearance distances around energized conductors. The higher the voltage the further electricity can jump in the event of arcing. For example, the arc flash boundary for distribution voltages (12 kV) is less than one foot, while for 500kV (voltage of interstate transmission) the boundary is nearly 10 feet (ArcAdvisor, 2014).

1.3 History of Vegetation Management

Prior to the revised standards issued by NERC in 2009, vegetation management requirements in the United States were primarily voluntary. The FAC-003-1 existed, but was primarily a best practices or recommendation document (FERC, 2009). On the state level, clearance requirements were established with the CPUC's adoption of General Order 95, regulating the operation and maintenance of electric transmission and distribution lines in California (State of California, 2012). This General Order was first published in 1941 and adapted into law in 1942. Over the years there have been several updates to the rule. The most recently update coming in 2012.

Early vegetation management within the utility right of way focused on manually clearing any fast growing tree species by manually removing it, typically with axes, mowers, or saws (Money, 2013). This removal would often lead to re-sprouting and additional growth within a few years. There were no mandatory survey requirements, so right of ways may not have been inspected annually. Conducting routine manual removals is not the most cost effective method for managing vegetation (Finley Engineering, 2010). In the 1950's utility companies began to introduce herbicide into their vegetation management strategy. These early herbicide applications were indiscriminate and killed the majority of vegetation within the right of way. Herbicide was applied by high volume delivery methods such as trucks (Money, 2013). The science behind the effects of some herbicides was not well known, and high concentrations of the herbicide were released into the environment, leading to possible contamination issues. For

example, early herbicide applications were in the range of 100 gallons per acre. Today vegetation managers can use approximately 15 gallons per acre to achieve the same goals (Money 2013). Herbicide application is also conducted selectively using fine grain application devices, like backpacks with hoses and nozzles. The herbicide application is targeted only on certain re-sprouting species (Money, 2013).

1.4 Issues Arising from Insufficient Vegetation Management

The following chapter will discuss the potential issues that can arise due to insufficient vegetation management within the utility right of way. Vegetation within the utility right of way can lead to power outages and safety issues for the utility company as well as significant fines.

1.4.1 2003 Northeast Blackout

The most well-known vegetation related electrical outage is the 2003 blackout in the northeastern United States and Canada. On August 14, 2003 a 230kV line in Ohio was sagging under the heat of the day. It brushed against a tree limb and caused a short circuit in the line (Scientific American, 2008). The utility company, FirstEnergy Corporation had an alarm system to alert operators of such an outage, but it failed. After the first line went down, other transmission lines were forced to carry the added electrical burden, in order to meet customer demand. FirstEnergy Corporation operators were trying to get the first line back on-line when three additional lines sagged and made vegetation contact, resulting in additional line outages. By 4 PM, the system was too overloaded and shut down, leading to cascading power failures between Ohio and northeastern Canada (Scientific American, 2008). Over 50 million people lost power for up to two days and cost $6 billion in lost revenue and repairs (Scientific America, 2008). There were 11 deaths stemming from the loss of power and this was the largest blackout in history. FirstEnergy Corporation was not fined as a result of this outage; the vegetation standards were not mandatory at the time (FERC, 2004).

As a result of the blackout, FERC and NERC conducted a comprehensive study of the utility, as well as the vegetation management and outage response plans of utilities across the country. This led to updated FERC vegetation management standards, making them mandatory,

and with more oversight from FERC. They also mandated operator qualifications for those in positions of outage response (FERC, 2009).

The blackout triggered a heightened sense of awareness around vegetation management for utility operators. After the blackout, regulators were also being more vigilant about auditing and ensuring that utilities were in compliance with the standard, and that other interconnection regions were not in similar danger (FERC, 2004). After the roll-out of FAC-002-1 FERC began levying fines on utilities that were out of compliance and causing outages. The largest fine to date was $25 million. This was levied on a Florida Utility Company (Carr, 2013). This outage was not vegetation related, but did impact system reliability and is indicative of the regulators renewed focus on compliance.

1.4.2 Fires in California

In addition to causing outages, vegetation can also result in fires, which can damage land and property. If arcing or direct contact between vegetation and electricity occur parts of the tree or plant can fall to the ground and cause wildfires. Cal Fire estimates that 1 to 3% of wildfires in California are the result of vegetation conflicts with power lines (Mitchell, 2009). The potential for fire can be especially worrisome during years of drought. Trees become stressed when there is not enough water and can become susceptible to disease and insect infestation. Combined, this can lead to widespread tree decline and death. Dead and dying trees can then drop branches on, or fall into electrical facilities, leading to downed wires, broken equipment, and fire. Electric transmission lines run through very remote forested areas of the state. If a fire were to start it could cause significant damage before it is discovered and addressed (Mitchell, 2009).

One of the most notorious wildfire cases in recent California history is the Trauner Fire. The fire began August 7, 1994 in the town of Rough and Ready; located in the Sierra Mountains in Nevada County. The fire burned 500 acres and consumed 12 homes and 22 structures, including a historic schoolhouse (Doyle, 1997). It was determined that the fire began when an oak branch made contact with 21kV distribution power lines. PG&E is the utility provider in this area and was guilty of inadequately maintaining vegetation clearances around power lines. The company was sued and found guilty of 739 counts of negligence for failing to trim vegetation around power lines. The company was forced to pay fines of almost $2 million (Doyle, 1997).

While this may be the most well-known case of vegetation caused wildfires, PG&E has also settled or been found guilty in 4 other fires throughout northern California. These fires all occurred during the 1990's and totaled 127,500 acres of damage (Doyle, 1997).

In 2007 Southern California Edison utility lines were involved in a devastating wildfire. The Grass Valley Fire started when a tree fell into power lines and caused a surge of electricity to super heat metal components and spark the fire. The fire was located in San Bernardino County and destroyed 174 homes, damaged 25, and burned a total of 1,247 acres (Barr, 2011). The fire destroyed parts of National Forest land. The utility was sued by the United States Forest Service as well as citizens and the HOA of the community that was impacted. SoCal Edison settled the federal lawsuit by agreeing to pay $9.6 million in damages to the USFS. The utility also had to contend with approximately 175 plaintiffs seeking retribution for damage to the community including economic losses and other damages. In December 2012 confidential settlements were reached with homeowners impacted by the fire. SoCal Edison did not admit liability in the settlement (Barr, 2012).

The propensity for California forests to burn, coupled with the number of electric power lines in the state, is a potentially dangerous combination. As discussed above there are numerous examples of high profile fire cases in northern and southern California caused by tree/power line conflicts. Comprehensive vegetation management is required to ensure that trees and other vegetation are safely outside of the right of and way in order to avoid future fires.

Summary:

Insufficient management of vegetation within the utility right of way can lead to a number of issues. There is a history of vegetation caused fires throughout California that have caused millions of dollars of damage and resulted in large fines for the utility company. In addition, vegetation is known to cause power outages by growing into or falling on electric lines. The largest power outage in history occurred in 2003 and was caused by vegetation. It is because of these dangers that utility companies must develop vegetation management programs that can guarantee vegetation clearances over time. This is an opportunity for companies to evaluate or implement integrated vegetation management plans.

Chapter 2. Vegetation Management Regulation

Utility vegetation management programs are regulated at the state and federal level. The utility companies are required to comply with multiple regulations that specify vegetation clearances and program requirements. The following section will describe the regulators and laws utility companies are subject to.

2.1 Regulatory Agencies:

The electrical transmission lines in California are overseen and regulated by multiple organizations at the state and federal level. The North American Electrical Reliability Corporation (NERC), Federal Energy Regulatory Commission (FERC), California Public Utilities Commission (CPUC), and California Energy Commission (CEC) are all involved in the oversight of; as well as setting the regulations that utility companies must comply with. In addition to the federal and state regulations utility companies may set individual operating procedures around vegetation and utility management.

The North American Electrical Reliability Corporation (NERC) is tasked with setting the clearance requirements for vegetation growing near electrical transmission facilities as well as defining what the vegetation management plans must consist of (FERC, 2013). NERC was founded in 1968 following the Federal Power Commissions investigation of the 1965 blackout in New York City and Canada. NERC brought together 12 regional electrical organizations throughout the country. NERC is a non-profit organization which is responsible for communicating between the Federal government and utility companies (NERC, 2012). They review the grid demands and the utilities ability to meet them. NERC is responsible for developing the vegetation clearance requirements (called standards) for electric transmissions lines (NERC, 2012). NERC does not develop the requirements for vegetation clearances around distribution lines. Distribution clearance standards and developed by the state's regulatory agency (FERC, 2013). This is discussed more in depth in the section on the California Public Utilities Commission.

The California Energy Commission (CEC) is responsible for planning and developing California's energy policy. They are also responsible for ensuring adequate energy safety and supply in the state of California (CEC 2014). The CEC was created through the legislature in 1974 to address California's energy needs. The passage of the Warren-Alquist act established the

State Energy Resources Conservation and Development Commission (former name for the CEC) (CEC, 2014). The CEC is run by a chairperson and 4 commissioners, all appointed by the governor, with 5 year overlapping appointments. There are seven major divisions within the commission covering the areas of transportation, energy supply, administration, siting and environmental protection, efficiency, renewables, and research and development (CEC, 2014). The energy supply and siting and environmental protection divisions are the two areas of the commission most directly associated with utility right of way management. The CEC has commissioned a number of studies from the Electric Power Research Institute (EPRI) and other organizations to evaluate issues associated with transmission line planning and siting (CEC, 2014).

The Federal Energy Regulatory Commission (FERC) has a hand in regulating and overseeing all energy lines of business in the United States (electric, gas, oil, etc.). They are responsible for the safety and reliability of both electric and gas transmission systems (FERC, 2013). FERC also reviews large transmission projects and licenses hydroelectric projects and facilities in the United States. FERC is responsible with reviewing and approving all new hydroelectric facilities in the US (Greenfield, 2010). Since FERC is primarily interested in system integrity and electrical reliability; they do have an interest in utility right of way vegetation management. FERC identifies tree/power line contact as the leading cause of power outages in the United States (FERC, 2013). FERC partners with NERC on studies focused on increasing electrical reliability in the United States (Greenfield, 2010). FERC must review and approve the utility standards that NERC develops and rolls out to utility companies. Utility standards cover aspects of right of way management such as vegetation management and clearances around transmission utility lines.

FERC is headed by 5 presidentially appointed commissioners. FERC may not have more than 3 commissioners belonging to the same political party, in an attempt to maintain their organization as independent from political influence (Greenfield, 2010). As a federal entity, FERC is funded by the United States, and must request a budget each fiscal year. There are three main divisions (called functions); the Administrative, Regulatory, and Litigation functions.

The predecessor to FERC was the Federal Power Commission. This group was formed in 1930 and its primary function was the coordination and development of hydroelectric facilities (Greenfield, 2010). In 1935 the Federal Power Commission was established as an independent

regulatory body and was appointed commissioners by the president. FERC decisions are reviewed by federal courts, not presidents or congress (Greenfield, 2010). In 1938 the Federal Power Commission was given oversight of gas facilities through the passage of the Natural Gas Act (Greenfield, 2010). In 1977 Congress passed the Department Of Energy Energy Organization Act which brought the FPC under the DOE branch in the government (Greenfield, 2010). At this time, the organization was also renamed FERC (Greenfield, 2010). Over the years, FERC's regulatory responsibilities have changed. The most recent act, the Energy Policy Act of 2005, expanded FERC's responsibilities around the transmission and sale of natural gas (Greenfield, 2010). FERC's creation and evolution over time demonstrates that electric (and gas) transmission in the United States has and continues to be a priority.

The California Public Utilities Commission (CPUC) is the state government body that provides oversight of all utilities in California (gas, electric, and water). The CPUC is led by a group of commissioners, appointed by the governor of California (CPUC, 2014).

One of the responsibilities of the CPUC is developing the vegetation clearance requirements for distribution electric lines in California. As mentioned above, NERC develops the standards for clearance related to transmission, but not distribution electric lines.

The CPUC is also responsible for establishing the rates of electric and gas for customers in California. In order to do this, the CPUC must review and evaluate the costs the utility companies will incur, and what they plan to spend on various programs each year. Every three years utility companies must submit a General Rate Case (GRC) to the CPUC. The General Rate Case is a document which discusses the cost of various programs at the utility (CPUC, 2014). It discusses the costs associated with operations and maintenance, new development and facilities, as well as other programs (CPUC, 2014). Within the operations and maintenance section the utility is required to discuss its vegetation management plan and costs. The GRC is reviewed thoroughly by the CPUC and can be denied or modified if the CPUC feels it is excessive or unnecessary. This reporting is incentive for utilities to have efficient vegetation management strategies and organizations within the company. Within the GRC a utility company is able to describe their program and justify costs.

2.2 Regulatory Requirements and Statutes

The utility standard for electric transmission vegetation management in the United States is FAC-003-2 (Vegetation Management Standard). The Final Rule, Order 777 was issued in March 2013 and utilities are required to be in compliance with the new standard on July 1, 2014 (FERC, 2013). This most recent ruling is a revision to version 1 of FAC-003-1. FAC-003-1 was produced in the 2000's and was the utility standard (NERC, 2006). This standard outlined transmission vegetation management plan requirements for utilities and line clearance standards based on the voltage and risk of power lines. The FAC-003-2 keeps much of the language of its predecessor, but it incorporates required timelines and reporting measures (FERC, 2013). These updates were added to the FAC-003-2 as a result of the 2003 blackout and subsequent research on reliability and utility practices conducted by NERC and FERC (FERC, 2009). Figure 1. At the end of this chapter provides an overview of the various regulators and laws.

The FAC-003-2 standard is for power lines over 100kVand transmission lines that are in the interconnection corridors (FERC, 2013). The standard establishes requirements around vegetation inspection, clearances, record keeping, funding, and other components of a comprehensive vegetation management plan (FERC, 2013). The original standard called for the transmission owner to decide and document the level of on the ground vegetation inspection. The updated version requires a physical inspection of vegetation in the utility corridor a minimum of once per year. The standard also requires the transmission owner to document the clearances they are achieving. The clearances must at a minimum be the level required in order to avoid flashover. The standards are established in 516-2003 Guide for Maintenance Methods on Energized Lines (FERC, 2013). Leaving the transmission owner to define their own clearance allows for the utility to comply with NERC requirements, as well as local requirements, or company policy (FERC, 2013). In addition to the technical requirements of the standard the transmission owner must develop a yearly vegetation management plant to be made available to regulators. The plan must include information on the methods of treatment (herbicide use, mowing, etc.) as well as planned workload for the year. They must address the timeline required for property owner notifications as well as length of time required to obtain environmental permits. The documentation of an integrated vegetation management plan would be found within a company's FAC-003-2 mandated vegetation management plan. Finally, the FAC-003-2

requires quarterly reporting to the transmission owners governing body of any vegetation caused outages on electric transmission lines (FERC, 2013).

In addition to the program requirements set out in the standard, it also establishes levels of non-compliance, or violation of the standard. Compliance with the standard is overseen by NERC (Greenfield, 2010). NERC is required to conduct field audits a minimum of once every five years, or more as warranted. Additional audits would be warranted if a utility is reporting vegetation caused outages. Violations to the code must be reported to NERC and FERC. There are fines associated with violations of the standard (FERC, 2013). These fines are levied by FERC after investigating the incident. The levels of non-compliance range from 1 to 4; level 1 fines are for violations that are the least impactful of system reliability (administrative type fines). Level 4 fines involve documented vegetation related outages or egregious violations (4 or more) of the utility standard (FERC, 2009). The fines range from tens of thousands of dollars up to a million dollars, depending on the severity and timeline of the violation (FERC, 2013). These fines represent a material threat to the utility companies' bottom line, so compliance is a priority of the vegetation management plan and the company.

At the state level, California utilities must comply with General Order 95 Rule 35 as well as Public Resource Code 4293 and PRC 4292 (PG&E, 2013). These standards are established by the California Public Utilities Commission and pertain the vegetation clearances. General Order 35 mandates that California utilities maintain clearances established by the CPUC for power lines (CPUC, 2012). The distance requirements are established in part by flashover potential, but also dependent on where they are located. For example vegetation growing around wires that cross railroad tracks is afforded a clearance of greater than 30 feet, whereas clearance of wires around non-walkable surfaces is only 8 feet (CPUC, 2012). Public Resource Code 4293 requires that owner operators of distribution and transmission lines maintain the following clearances: 2400 voles – 72,000 volts 4 feet. 72,000- less than 110,000 volts 6 feet. Any line over 110,000 volts 10 feet (PG&E, 2014). These clearances must be maintained at all times including when temperatures are high and the lines sag. They must also provide clearance in the event that trees are water logged or carrying a snow load. Public Resource Code 4292 regulates fire break and clearance requirements (PG&E, 2014). At the ground level around poles, all flammable materials (duff, grasses, any vegetation that can spread fire), must be cleared. Between ground level and 8 feet up the power pole/ between power poles all flammable vegetation and any encroaching

limbs and living vegetation must be removed. From 8 feet to the height of the conductor (typically around 35 feet off the ground) all dead, dying, or diseased limbs or trees must be removed (PG&E, 2014). As with the FERC and NERC federal requirements, California state requirements are very precise and measurable. The state regulations take into account the ground cover and area of the power lines, in addition to flashover potential.

2.3 ANSI Standards

ANSI (American National Standards Institute) develops and publishes work standards and guidelines for work activities across almost every business sector. The American National Standards Institute is a 501 (c) 3 non-profit organization with the goal of increasing the competitiveness of US businesses across the world through the standardization of business practices (ANSI, 2014). The ANSI standards are not mandatory or regulatory standards. They are established by the institute as best management practices based on input and consultation with multiple professional organizations. They are recognized as the trade standard, but are in no way enforceable and carry no penalties for non-compliance. ANSI A300 is the approved standard that deals with vegetation management around utilities (ANSI, 2014). This standard lays out the best management practices for managing vegetation around utilities and is comprised of 9 sections (ANSI, 2014). The A300 standard is broken down into parts 1 through 9 and addresses pruning, soils, support systems, lightening protection, management, planting, integrated vegetation management, root management, and tree risk management. ANSI A300 standards were written by the Tree Care Industry Association (Tree Care Industry Association 2013).

ANSI A300 Section 7 addresses Integrated Vegetation Management. This section describes the creation and implementation of an integrated vegetation management program at a utility (Tree Care Industry Association, 2013). The standard addresses site selection of right of ways that could potentially benefit from integrated vegetation management as well as a discussion of control methods. In integrated vegetation management, there are 3 primary control methods: cultural, biological, and chemical (Tree Care Industry Association, 2013). Cultural control methods involve the introduction (or re-introduction) of native plant species as well as more appropriate vegetation communities to outcompete the undesired vegetation within the right of way (Oregon DOT, 2011). Biological control methods entail the utilization of natural

predators to combat unwanted vegetation. The biological controls can be implemented to control the fast growing vegetation, or used to combat non-native invasive plants that may have overtaken the right of way after initial over story clearing (ex. Scotch or French broom). Finally, chemical control involves the utilization of herbicides to meet vegetation goals. Generally, only EPA approved herbicides are used according to direction (Oregon DOT, 2011). The herbicide is a transitional tool, and typically selectively applied on a small scale, through the use of a backpack and nozzle. Selective application is defined as applying the lowest level, non-residual herbicide only to plants with potential for stump or re-sprouting, or noxious weeds (Money, 2013)

Figure 1. Electric Utility Regulations

Level	Regulation	Description
Federal	FAC-002-003	Post-2009 vegetation standard for electric transmission owners and operators. This builds on FAC-001-003 and mandates fines for violations.
	FAC-001-003	Pre-2009 vegetation standard for electric transmission owners and operators.
State	PRC 4293	Public Resource Code that specifies the vegetation clearance requirements based on electrical line voltage.
	PRC 4292	Requires electrical power line owners and operators to maintain fire breaks around power poles.
	GO 35	Requires electric utilities to adhere to clearance standards established by the CPUC.
Other	ANSI 3007 Section 7	Industry standard, not legally enforceable.

2.4 Penalties and Non-Compliance

As discussed above, violations of FAC-003-2 present a material threat to a company's business. The fines assessed are determined by NERC, and approved by FERC regulators and incorporate the violations severity level, as well as the violation risk factor (Greenfield, 2010). Violation severity level is a measure of how severely the requirement was violated. Violation risk factor is a measure of the amount of risk the violation presents to the utility corridor. Between the roll-out of the new utility reliability standard in 2009, and 2013, utilities have paid more than $150 million in fines. According to the standard maximum penalties could amount to one million dollars a day per violation (for violations with both high violation risk factors and high violation severity levels) (FERC 2013). In 2009 Duke Energy was forced to pay approximately 2 million to settle a vegetation non-compliance issue which led to a flashover caused outage (Bracewell, 2009). Also in 2009, Baltimore Gas and Electric Company was fined $180,000 for violation of their Transmission Vegetation Management Plan (TVMP) (Bracewell, 2009). Finally, MidAmerican Energy Company was forced to pay over $100,000 in fines and penalties for allowing a tree to grow within the right of way and causing an outage (Bracewell, 2009). These penalties were levied under the FAC-003-1 standard (Bracewell, 2009). With the adoption of FAC-003-2 standard, penalty amounts and frequency of penalties are likely to increase.

The CPUC also levies fines against utility companies for violations of PRC 4292, 4293, as well as GO 95 Rule 35. Individual violations to these codes and rules are evaluated by the CPUC and a commission determines the fines to the company (CPUC, 2014). The company may also be mandated to pay restitution to the state of California. For example, in 1999 PG&E was fined $6 million to be paid to the state and was required to use $22.7 million of shareholders money to fund various vegetation program upgrades and inspection protocols (CPUC, 2012).

In conclusion, there are regulations placed on utilities by both the federal and state governments to manage vegetation within the utility right of way and around electric facilities. The regulations are meant to ensure system reliability and safety. The American National Standards Institute has developed a standard; A300 regarding best management practices for utility vegetation management. This standard is not a regulation and offers no compliance mandates, but is an industry wide practice. The state and federal electrical regulators have

authority to impose fines on companies that violate regulations. These fines can range from several thousand dollars up to one million dollars a day per violation. This represents a material threat to the company and compliance must be taken seriously, or there could be financial impacts.

The updated and mandatory vegetation management standard, along with the potential for million dollars per day fines, represents a challenge for utility companies. The size of the potential fines represents a material threat to the company and a major outage could be a public relations disaster for the utility. This requires the utility to have a thorough understanding of the plant communities through which the power lines run and to develop and comprehensive, predictable vegetation management plan. In the wake of 2003 blackout there is an opportunity for a more widespread application of integrated vegetation management as a way of mitigating the threat of vegetation caused outages.

Utility companies do not have the same strict regulations regarding clearances in their gas line right of ways. The utility is required to protect any above ground portions of the gas line from overhead threats. The gas pipeline utility must be able to access all of their pipeline right of ways in order to conduct surveys and routine as well as emergency activities (PG&E, 2014). While there may not be clearance requirements, if a utility is unable to quickly deal with an emergency situation, repercussions are likely from federal and state regulators.

Chapter 3. Vegetation Management Strategies of the Major Utilities in California

The three largest gas and electric utility providers in CA are Pacific Gas and Electric Company (9.4 million customers), San Diego Gas and Electric (3.6 million customers), and Southern California Edison (14 million customers). Collectively these three companies provide service to over 27 million Californians. While not in direct competition with each other, due to their unique service areas, the companies still have an incentive to keep the electricity reliable and the prices low.

Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison state that they are currently utilizing integrated vegetation management around their electric rights of way. The budget information for these programs is discussed more in depth in the following section. Based on a review of the budget information, the vegetation programs at

these utilities are cycle or treatment based. They plan and budget to cut or treat a large amount of vegetation on an annual basis. This would indicate that the rights of ways are not actually being converted to a more compatible vegetation structure as would be seen with an integrated vegetation management plan. Instead, the utility companies are continually dealing with incompatible vegetation.

PG&E provided the most information regarding their vegetation program and will be discussed in the following paragraphs. The goal of PG&E's vegetation management program is to convert all rights of ways to low growing vegetation through the combined use of IVM, mechanical removals, and herbicide (PG&E, 2014). Following the initial clearing of a right of way (as done for installation of new facilities), the right of way is monitored for sprouting and regrowth, and treated appropriately with herbicide (PG&E, 2014). When tree trimming is required, PG&E attempts to get large clearances that will maintain compliance for multiple years, in order to increase efficiency (PG&E, 2014). PG&E's distribution vegetation management is based on an annual cycle of inspection and treatment (PG&E, 2014). PG&E did not provide any additional information regarding its approach to IVM. There were no examples of successful (or unsuccessful) use of the strategy on its right of way, or areas that would be targeted for IVM.

PG&E was also the only utility researched to discuss vegetation management within its gas line right of ways. PG&E is currently in the process of clearing gas line right of ways of incompatible vegetation and structures (PG&E, 2014). This is a new effort that would be considered to be similar to the initial clearing required for installation of a new facility. PG&E also provides a contracted tree root study. The tree root study indicates that when tree roots interact with pipelines there is a high occurrence of pipeline coating damage (PG&E, 2014). This potential for damage requires the company to manage trees within the gas line right of way and helps to explain the new push to clear gas line right of ways.

3.1 Annual Costs and Budget information

Pacific Gas and Electric Company spent approximately $180 million on vegetation management programs in 2012 (PG&E 2013). SDG&E spends about $21 million on vegetation management (most vegetation management work is contracted) (SDG&E 2010). Southern

California Edison spends a similar amount each year on vegetation management of an inventory of approximately 1.4 million trees within their service territory (Southern California Edison, 2013). The difference in budgets can be linked to the relative size of the utilities territory. PG&E's service territory is 70,000 square miles primarily around northern California. The vegetation in this part of the state consists of many tall growing tree species. Southern California Edison's service territory is about 40,000 square miles and is located in the south and eastern portion of the state. Much of this land is desert with little need for tree removal. San Diego Gas and Electric operates a 4,100 square mile territory on the southern coast of California. Each of these utilities is required to conduct an annual complete inspection of their lines per the NERC requirements (FAC-003-1). They must then conduct treatments as needed. These utility companies all have a number of public outreach policies and strategies to educate and involve the public in vegetation management (PG&E, 2014, SDG&E, 2014, SCE, 2014).

Fully integrated vegetation management programs have an initial higher cost, but show reduced costs in the long term (Caroll, 2010). Reduced costs stem from avoided maintenance and emergency response needs (Caroll, 2010). A study conducted by the Caroll Electric Cooperative in 2010 found the cooperative could save $50-70 million over 30 years by continuing to implement integrated vegetation management. This represents a 4-6 times savings over mechanical vegetation management as is consistent with the industry estimated savings (Caroll, 2010). The Caroll Cooperative's vegetation management requirements are similar to the vegetation requirements of California's utilities. The Caroll Cooperative manages the floor and walls of utility right of ways for vegetation encroachment (Caroll, 2010). The findings of this study can be used to inform vegetation management decision making in California.

An integrated vegetation management program ultimately has the goal of reducing the number or amount of incompatible vegetation within the right of way. This is where the cost savings of IVM are found. A reduction in the number of trees that require treatment (whether manual treatment or application of herbicide) ultimately reduces the cost of management. Research on integrated vegetation management has focused primarily on measuring density and species type of vegetation within a right of way following various treatment types. These studies examine test plots within the right of way over many years (Yahner, 2005).

Research by Yahner in the 2000's was focused on measuring tree and vegetation densities on an experimental right of way in Pennsylvania. Yahner utilized test plots that were

then treated with either manual treatments only (mowing or use of chainsaws), or manual removal with an herbicide treatment. Tree control was found to be excellent in the plots that utilized both mowing and herbicide treatments (Yahner, 2005). The control of trees in the manual removal only plots was found to be poor (Yahner, 2005). Yahner completed a second inventory 5 years after the treatment and found that incompatible vegetation had increased at a higher rate in the non-herbicide plots (manual treatment only) than in the combination of treatments plots (Yahner, 2005). A reduction of tree inventory means fewer treatments and a reduction in costs to the utility company. This is an example of the cost savings that can be found within the adoption of an IVM program.

The Electric Power Research Institute in cooperation with the Empire State Electric Energy Research Corporation (ESEERCO) conducted research to determine the cost per acre of various vegetation treatment methods. The study looked at hand cutting, mowing, cutting and herbicide treatment (cut stump), dormant basal herbicide treatment, summer basal herbicide treatment, selective ground foliar treatment, and aerial treatment (EPRI, 2000). The research found that on a per acre basis, regardless of stem density (density ranged from 1,000 stems per acre to 4,500 stems per acre), hand cutting was the least expensive method of management. Dormant basal herbicide treatment was the most expensive per acre method regardless of density (EPRI, 2000). In terms of effectiveness, it was found that all herbicide treatments resulted in a target vegetation reduction of over 70% (EPRI, 2000). For hand cutting, the reduction in stems was less than 10%, and the reduction for the cut stump strategy was 55% (EPRI, 2000). Manual removal was found to be not effective in reducing the number of stems within the right of way (EPRI, 2000).

The primary benefit of integrated vegetation management to a utility company is cost savings. As discussed above, the utility companies in California spend millions of dollars per year on vegetation management. A reduction of costs for operation and maintenance activities would benefit the company's shareholders and could potentially free up money for other programs. The Yahner and EPRI research found that combinations of treatment methods are the most effective at reducing stem count. Reducing stem counts in the right of ways saves utility companies money through the reduced need for treatments. Integrated Vegetation Management utilizes this approach in utility right of way management.

In addition to cost savings, the utility company can achieve other benefits from integrated vegetation management. Integrated vegetation management has ecological benefits (as shown in the National Grid case study) which a utility company could benefit from. One of the core values of PG&E is to protect the environment (PG&E, 2014). As discussed, Integrated Vegetation Management can create habitat for native and endangered species and is less impactful on the environment. These are both examples of protecting the environment that PG&E would be able to report out to shareholders and the public. All three utility companies produce an annual sustainability report that is released to shareholders and the public. The ability to report environmental benefits from integrated vegetation management to shareholders and the public provides a non-monetary benefit to the utility company. The table below summarizes the benefits of integrated vegetation management.

Table 2. Costs and Benefits of Integrated Vegetation Management

Method	Benefits	Costs
Integrated Vegetation Management	-Habitat creation -Reduced outages -Ecosystem management -Meets corporate sustainability goals	Initial costs high (depending on status of right of way). Long term cost savings (4-6 times less than traditional management).
Mechanical management	-Less expensive initially -requires less management and oversight	4-6 times more expensive over 30 years (Caroll, 2010).

3.2 Reliability Indexes

Utility companies are required per California Independent System Operator (CA ISO) requirements to maintain a log of all power outages. The CA ISO sets standards for reliability that the utility companies are measured against. The CPUC requires that utility companies submit three different scores. The SAIDI (System Average Interruption Duration Index) measures the number of minutes of sustained outage per customer per year. The SAIFI (System Average Interruption Frequency Index) measures the number of outages per customer per year.

The MAIFI (Momentary Average Interruption Frequency Index) measures the number of momentary outages per person per year (CPUC, 2014). Each of these outage measures provides important information to the public regarding the utilities reliability. As discussed above, vegetation issues are the number one cause of power outages in the country. While not all outages can be attributed to vegetation, these reliability scores can be used as an indication of the utilities success with its vegetation management programs.

3.2.1 PG&E Reliability Scores

PG&E provides the last 10 years of outage data in its 2013 reliability report (PG&E, 204). The outage occurrences measures by each of the reporting indexes have all declined over time (PG&E, 2014). PG&E also describes the top 10 largest outages of the past year. The report indicates that the largest outages were all weather related and were caused by significant precipitation or unusually strong winds (PG&E, 2014). This is a good sign for the company's vegetation management program. No major outages were directly vegetation related. The CPUC defines a major outage as non-earthquake weather related outage that affects between 10% and 40% of customers (CPUC, 2014). Overall, PG&E has been able to demonstrate a significant reduction in SAIDI and SAIFI events (PG&E, 2014). When data is reviewed on a regional or divisional basis, PG&E has made the most advances in the Sierra and North Coast regions (PG&E, 2014). These regions encompass heavily forested and remote areas of the territory (PG&E, 2014). It can be assumed that with the access issues (caused by remote power line locations), and the majority land cover type being forest, that PG&E would historically have had issue managing vegetation in these divisions. This large (greater than 60%) reduction in the frequency and duration of outages shows an investment in reliability programs by the utility. Reliability work includes updating and maintaining infrastructure as well as operations and maintenance activities such as vegetation management.

3.2.2 Southern California Edison Reliability Scores

Southern California Edison data shows that over the past 10 years, the number of SAIDI events has increased nearly 39% (Southern California Edison, 2014). SAIFI and MAIFI events

have reduced slightly (32 and 0.08%, respectively) (Southern California Edison, 2014). Southern California Edison's analysis of the causes of major events reveals that the company suffered many outages due to wildfire (Southern California Edison, 2014). This is to be expected, as the utility maintains power lines within the southern California mountains, which are subject to varying intensities of fires every year. The utility summarizes the cause of the top 10 major SAIDI events by year. For 2013, of the top 10 major SAIDI events of the past, the utility discloses that 4 of them were somehow caused by vegetation (Southern California Edison, 2014). In 2011, 7 of the top 10 major events were contributed to vegetation. The vegetation caused outages were more prevalent in recent years (2010-2013); historically the major SAIDI outages were attributed to weather events and wildfire (Southern California Edison, 2014). The utility does note that they have had significant issues with bar beetle damaged and declined trees in recent years (Southern California Edison, 2014). Following wildfires, bark beetles can move in and further impact the distressed trees. This will often lead to mass die of pine and fir stands (Southern California Edison, 2014).

3.2.3 San Diego Gas and Electric Reliability Scores

San Diego Gas and Electric has shown a downward trend in SAIFI, SAIDI, and MAIFI events over the past 10 years (San Diego Gas and Electric, 2014). The MAIFI events have been reduced by more than half (0.614 to 0.211), SAIFI events dropped almost 17%, and MAIFI events decreased by almost 20% (San Diego Gas and Electric, 2014). During 2013, SDG&E reported that 2 of its largest outages were tree related. The causes of the top 10 outages over the past 10 years indicate that very few SDG&E outages are tree related. There are several years in which vegetation is not identified as a cause (San Diego Gas and Electric, 2014).

The outage data for PG&E and SDG&E indicated a downward trend in both number and frequency of outages as well as their duration. This is beneficial to the company and utility customer and is the trend which regulators would like to see continue. Vegetation is the leading cause of electrical outages in the United States (FERC, 2013). Given that PG&E and SDG&E have been able to reduce their outages we can assume that their vegetation management programs have been fairly successful. Looking at the data for PG&E, the two divisions that were able to reduce their outages the most were located in the primarily forested Sierra and North

Coast divisions. Improved vegetation management, or a more focused vegetation management program, in these areas no doubt helped the company improve their reliability. While a much smaller company, SDG&E was also able to make gains in their reliability scores. This company manages utility lines in wildfire prone areas and through heavily forested terrain (San Diego Gas and Electric, 2014). Their improved reliability scores indicted that they have also been able to find ways to deal with tree and vegetation issues, including impacts from bark beetle infestations. Southern California Edison has not shown downward trends in the frequency and duration of their outages over the past 10 years. The frequency as well as duration of outages has increased. As discussed in their 2013 reliability report, Southern California Edison has had to deal with the impacts of large bark beetle infestations as the result of significant wildfires over the past 10 years. While it is not distinguished in the reliability report, we can assume that Southern California Edison is having issues managing edge, or corridor trees that are failing into the lines and leading to outages. Dead and dying vegetation also present a management challenge to utility right of way managers.

Summary:

Overall, utility companies in California have been able to improve their reliability scores over the past 10 years. Electrical reliability and outages are monitored by state and federal regulators and fines can be assessed for issues. Reliability scores can be used as an indication of the success of a company's vegetation management program, as vegetation is the number one cause of outages. Thus, over the past 10 years, vegetation management plans at the largest utilities in California have improved. The following chapter will look at examples of benefits besides improved reliability that can be achieved through Integrated Vegetation Management.

Chapter 4. Examples of Applied IVM

Utilities across the United States have begun to implement integrated vegetation management. The strategy of IVM can be utilized in the effort to preserve habitat for rare and endangered species (Chazen, 2012). By selectively managing the vegetation structure, land managers can create conditions that are suitable for rare plants, insects, as well as vertebrate species (Beran, 2005). Integrated Vegetation Management can manage vegetation to create

suitable conditions for rare and native plant species and can help to create the foundation for stable ecosystems (Beran, 2005).

In addition to creating new habitat, IVM can help in the creation and protection of wildlife corridors (Bodin, 2011). The utility corridors run throughout the countryside and can connect isolated islands of wild areas to one another. Due to the increase of land development throughout what were once open wild lands, small sections of undeveloped land can become what are known as islands. These areas contain favorable habitat for species, but are completely disconnected from other suitable areas of habitat. This can bottleneck populations and compromise their long-term survivability. Being able to connect these wild areas would allow previously isolated breeding populations to interact and increase genetic diversity, as well as create many acres of additional habitat. This could help increase the numbers of threatened and endangered species.

Right of way corridors can also be managed as edge or early successional habitat. Early successional habitat is the first regrowth after a catastrophic environmental event such as fire, micro burst, tornado, etc. (Bullock, 2006). Early successional habitat can serve as important foraging and grazing habitat for a number of bird species (including raptors). Utility right of ways offer a relatively undeveloped stretch of edge habitat (Bullock, 2006).

The following section will discuss an example of integrated vegetation management within a utility corridor in New York. This study looked at the effect integrated vegetation management had on rare plant communities and pollinators. This study helped to inform vegetation managers and utility operators, as well as regulatory agencies and can be used as a basis to revise or update utility vegetation management best management practices and regulations.

4.1 National Grid's HCP for Operations and Maintenance Activities

National Grid is an electric and gas utility providing service throughout New York State and the northeastern US. The company owns and operates several thousand miles of transmission utility corridor in upstate New York between Glens Falls and Oneida (Chazen, 2012). This area is part of the historic range of the Karner blue butterfly and the frosted elfin butterfly. The Karner blue is a federally and New York State listed endangered species. Federally and state

listed endangered species are protected from take through human activities. Take is defined in Section 3(18) of the Federal Endangered Species Act (FESA) as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." (NYSDEC, 2010). The New York State endangered species regulations define take very similarly as the “pursuing, shooting, hunting, killing, capturing, trapping, snaring and netting of any species listed as endangered or threatened in this Part, and all lesser acts such as disturbing, harrying or worrying” (NYSDEC, 2010). The frosted elfin butterfly is not federally listed, but is a New York State threatened species. Threatened species are those that are federally threatened or native to New York State and are in jeopardy of becoming endangered in the foreseeable future (Conserve Wildlife Foundation, 2014). New York State threatened species are offered the same protections as endangered species (NYSDEC, 2010). The protection status of these two species and the requirements of vegetation management on utility right of ways are in conflict. Nation Grid is not able to successfully complete vegetation management without potential for take of the Karner blue butterfly and frosted elfin (Chazen, 2012).

The New York State and Federal Endangered Species Acts do allow for some limited take of both of these species through the issuance of Incidental Take Permits (ITP). Incidental Take Permits are issued by the United States Fish and Wildlife Service (USFWS) for FESA and by the New York State Department of Environmental Conservation (NYSDEC) at the state level (Chazen, 2012). The ITP requires an applicant to prepare a comprehensive environmental document (biological assessment) which describes the project, its impacts (temporary and permanent) to suitable habitat, potential avoidance and minimization measures, and proposed mitigation. ITP’s can be granted on a project specific basis or can be granted on a larger scale with the preparation of a Habitat Conservation Plan (HCP) (Chazen, 2012).

As a method of dealing with the conflict between operations and maintenance gas and electric activities, such as vegetation management and the two special status butterflies, National Grid developed a Habitat Conservation Plan (HCP), which provided take coverage for both of the butterflies (Chazen, 2012). The HCP covers routine operations and maintenance activities within the utility right of way for both gas and electric operations. The permit is valid for 50 years (Chazen, 2012).

Through eight years of baseline surveys completed prior to the issuance of the HCP, National Grid found that right of ways within the Karner blue butterfly and frosted elfin range

which had been treated for incompatible vegetation; the host plant (blue lupine) had increased in abundance and density (Forrester, et al. 2005). The increase in the host plant abundance led to an increase in the populations of the Karner blue butterfly and frosted elfin (Chazen, 2012).

National Grid, in consultation with USFWS and NYSDEC, determined that 2 transmission rights of ways are critical to the recovery plan for the KBB and FE (Chazen, 2012). National Grid continues to manage the right of ways as habitat while also being able to continue the required operations and maintenance activities. The right of ways and parcels that hosted the greatest number of lupine plants is required to be managed through an intensive Integrated Vegetation Management program. The lines are actively monitored and incompatible vegetation is routinely removed to keep the right of way a desirable habitat for blue lupines (Chazen 2012).

In this example, National Grid was able to utilize some of their own properties as mitigation lands, this has multiple benefits. First, the most beneficial lands for the Karner blue butterfly and frosted elfin are being preserved and restored, instead of purchasing off site mitigation. It can be more desirable to be able to mitigate or restore habitat on site of construction activities than it is to purchase off-site mitigation (Chazen, 2012). Through the 8 years of baseline studies, National Grid was able to demonstrate that the utility right of way was being utilized by the species and that there was an opportunity to connect several island populations through the enhancement of the utility corridor (Chazen, 2012). In addition to the on-site mitigation, National Grid also agreed to purchase mitigation credits as well as fund restoration efforts of non-profits in the area (such as The Nature Conservancy). National Grid also conducts public outreach and education on the Karner blue butterfly and frosted elfin (Chazen, 2012).

On right of way easements not owned by National Grid, there is still opportunity conduct vegetation management and provide habitat for Karner blue butterfly and frosted elfin, but it is not under any obligation to conduct Karner blue butterfly and frosted elfin surveys. As discussed in previous chapters, easements through private property are not owned by the utility company; rather they grant the utility company certain rights. So, National Grid cannot be held responsible for the maintenance or other activities of join easement holders (Chazen, 2012).

In conclusion, National Grid was able to utilize their privately held land, as well as land with easements as habitat for two endangered butterfly species. Without the preservation and restoration of these utility corridors, the recovery of the species would be in jeopardy (Chazen,

2012). By partnering with USFWS and NSYDEC National Grid was able to integrate the requirements of blue lupine into their integrated vegetation management plan. In doing this, National Grid was able to obtain Incidental Take Permits for the two species of concern, which otherwise could have made it difficult to conduct routine operations and maintenance activities around their facilities while maintaining compliance with New York and Federal endangered species protection laws. This example shows that a comprehensive integrated vegetation management plan can not only be beneficial to the utility through savings, but can also provide an opportunity for in house mitigation. In addition to saving a utility company money, it also provides high quality, desirable mitigation lands and helps foster a positive working relationship with regulatory agencies.

Chapter 5. Methodology

Utility companies were evaluated by size (number of customers and service area were considered) and the three largest in the state of California were selected for evaluation. Pacific Gas and Electric, San Diego Gas and Electric, and Southern California Edison were found to be the largest in the state. The utility companies' current vegetation management strategies were examined through evaluation of reliability data, scope and budget of vegetation management program, as well as the companies own definition of their program. This program information was then compared with integrated vegetation management strategies adopted by other utility companies in the United States, as well as industry best management practices. If the company reported that it was currently utilizing IVM, areas for improvement were researched.

The analysis portion of the research involved looking at cost and benefits of various management strategies at the utility companies. For example, the cost of non-IVM vegetation management may be low, but is it meeting the company's environmental stewardship goals, GRI requirements, or sustainability goals? The non-monetary achievements of IVM (environmental stewardship, good PR, etc.) were considered benefits and weighed into the evaluation of the strategy. Additionally, avoided costs (fines, outages, fires) were considered as benefits to the company. This data was framed against the current policy and regulatory requirements, and policy suggestions were determined.

In addition to evaluating current company strategies, a review of existing case studies of IVM implementation was conducted. The research studies reviewed focused primarily on electric utility right of ways and were conducted throughout the United States. Studies of rare plants, mammals, and insects/pollinators were reviewed. Finally focus areas were identified by researching critical habitat designations for various imperiled California species. As a result of this research, the paper will conclude with right of way management policy recommendations impacting both regulators and utility companies

Chapter 6. Potential Benefits of Improved IVM in California

As discussed above, utility companies in California are currently utilizing aspects of integrated vegetation management within their utility right of ways. There is potential for utility companies to expand the scope of integrated vegetation management within their territories, perhaps even incorporating it into long term permitting strategies.

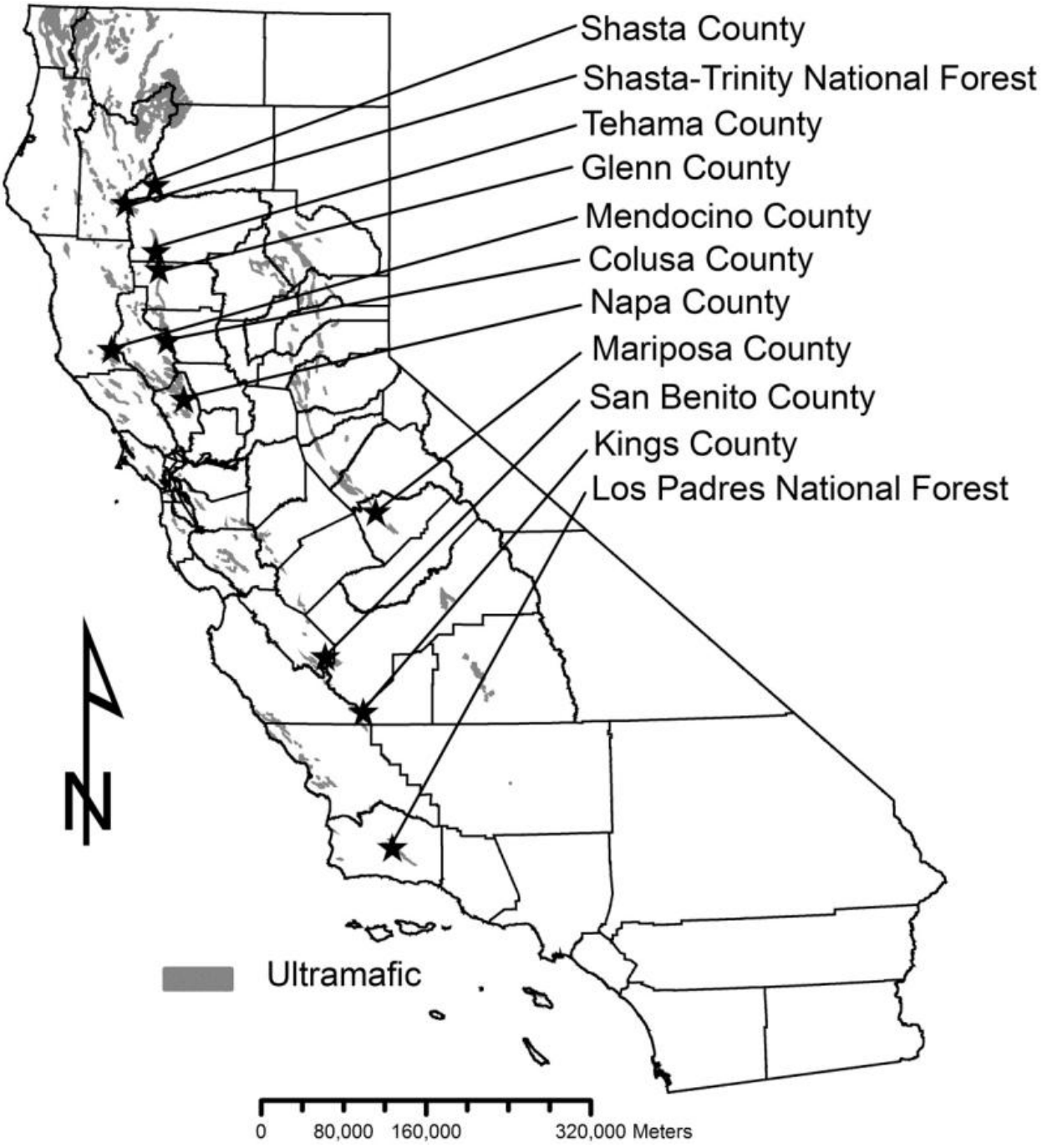
6.1 Focus Areas

Comprehensive integrated vegetation management could have the greatest environmental impact in areas with high concentrations of endemic, rare plants or in areas with high densities of utility right of ways. It would also be beneficial to conduct integrated vegetation management on the utility right of ways where rare plants or species that rely on those rare plants have been found historically. If there are small populations of a specific plant known at a gas line mile point or transmission tower, expanding the IVM upstream and downstream of that point could afford the species more habitats to grow. Utility companies would be interested in implementing IVM in areas that experience non-compliance or outage events (such as areas with abundant fast growing tree and weed species).

California is one of a few western states in North America that contains serpentine soils. Serpentine soils contain a rare combination of soil that contains naturally occurring asbestos. This naturally occurring asbestos provides a unique habitat and is associated with a high degree of endemism. Serpentine soils represent only about 1% of the land in California, but contain

approximately 10% of California's endemic plants (CNPS, 2014). Endemism is an ecological descriptor of a plant or animal species which is only found, and can only live in a specific and fixed geographic region. The figure below shows the distribution of serpentine soils in California and southern Oregon. Due to the species narrow habitat requirements, endemic species have high rates of becoming threatened, endangered, and extinct (CNPS, 2014). The serpentine habitat in parts of California is declining due to human development and expansion. Where habitat is not being lost to development, there is the threat of natural communities losing ground to non-native and/or invasive species. Many invasive plant species are agricultural or botanical escapees. These plants can out compete native endemics by reproducing more quickly and being able to grow on diverse landscapes. Invasive plant seeds are spread by vehicle and foot traffic as well as through animals. Highway corridors are especially prone to infiltration by invasive plants. Competition by non-native/invasive plant species is a major issue throughout California.

Figure 1. Serpentine Soils of California



(Soil Science Society of America, 2009)

The California Native Plant Society (CNPS) lists 15 species of CNPS ranked plants that require serpentine soils in its database. These 15 plants are primarily herbs and require montane or serpentine soils to grow. Three of the plants are level 1 CNPS species. Level 1 species are the rarest of CNPS rankings and there are a limited number of sittings in the wild. The listed species are found primarily in northern California (between Santa Rosa and Eureka, with another hot spot concentrated near the Oregon boarder), on the eastern side of the mountain range that runs through Mendocino (CNPS, 2014).

This area of the state is primarily within PG&E's northern service territory. The northernmost location along the Oregon boarder fall within PacifiCorp and Trinity electric's service territory (CPUC, 2014). These companies vegetation management protocol was not evaluated as part of this research. The eastern portion of the mountain range in northern California is heavily forested primarily by pine and fir, so any utility corridors would experience significant alteration of the native ecosystem. A utility company would be required to conduct an initial significant clearing effort and then routinely eliminate re-sprouting. This would entail significant manual removal as well as a concentrated herbicide effort. This would also present an opportunity for invasive species such as scotch or French broom to overtake the corridor. Integrated vegetation management strategies could be implemented in these corridors to manage the re-sprouting while providing habitat opportunities for the serpentine dependent plants.

It is important to note that the utility easements in this area transect federal property ownership. The Humboldt and Mendocino National Forest are located on this mountain range and are holdings of the federal government. There are restrictions to implementing some components of IVM on federal properties. The land just north of San Francisco, the Marin Headlands is also federally property; and part of the Golden Gate National Recreation Area. This area is managed by the National Park Service. Generally, the application of herbicide within federal boundaries requires significant environmental review and compliance with both the California Environmental Quality Act and National Environmental Policy Act. As a result of these onerous environmental evaluation and reporting requirements, utilities and other easement holders will generally avoid the use of herbicide on federal lands. This regulatory requirement presents a challenge to the comprehensive implementation of IVM; however it can be resolved by working closely with the forest service and completing the environmental review and public comment requirements.

In addition to being able to restore and improve habitat to endangered plants, the utility corridors running through and around the Marin headlands could be utilized as habitat for endangered invertebrates. The mission blue butterfly is a fully protected lepidopteron species confined to two swaths of land in the San Francisco Bay Area. The only populations of the Mission blue butterfly known are found in the southern Marin headlands, twin peaks in San Francisco, and portions of the San Francisco peninsula (GGNPC, 2014). The mission blue butterfly has two life stages; the larval and adult stage. Both life stages are dependent of the lupine plant, which thrives in serpentine soil environments with abundant sunlight. Adults oviposit eggs on the lupine and adult butterflies will only feed on the nectar of another type of lupine (GGNPC, 2014). The mission blue butterfly has a very specific food source and life stage. They feed only on certain types of lupines and nothing else. It cannot cross any open barriers (such as paved roads or streams) and requires low growing herbaceous vegetation as refuge (GGNPC, 2014). Utility right of way corridors present an opportunity to meet the life stage requirements of this species through the implementation of integrated vegetation management.

6.2 HCP Connection

The use of integrated vegetation management presents the opportunity for a utility company to restore and maintain large sections of easement land in a natural state. As discussed in depth above, the condition of right of ways can present the opportunity for habitat preservation for a number of species. Utilizing an easement as habitat can have multiple benefits for a utility company. Restoration and preservation actions have environmental value, as well as being an opportunity to meet stewardship and environmental goals for the company.

Utility companies must routinely acquire Incidental Take Permits or engage in informal consultation with resource management agencies such as California Department of Fish and Wildlife and the United States Fish and Wildlife Service. Communication with these organizations is triggered when utility project activities present a risk to threatened or endangered species. Typically, a utility will obtain Incidental Take Permits on a project by project basis. PG&E has created a Habitat Conservation Plan for their gas and electric operations and maintenance activities within the San Joaquin Valley (PG&E, 2014). San Diego Gas and

Electric and Southern California Edison have also adopted HCP plans for specific sections of transmission pipeline or specific projects (SDG&E, 2014).

As part of an HCP, the company must purchase, often up front, mitigation lands to compensate for the impacts to species habitat as a result of project activities. Mitigation lands are very expensive; credits for some species in California range from $25,000 an acre up to $40,000 an acre. The mitigation lands must be purchased within the same region as project activities, which can limit purchasing opportunities

Habitat conservation plans are a take permit under Section 10 of the Federal Endangered Species Act. When take of an endangered species is possible in a project, consultation with the federal regulatory agencies must be implemented. The California state equivalent to a habitat conservation plan is a natural community's conservation plan. Both of these plans allow for take of a species during project activities. In order to obtain the permits, the application organization must develop a comprehensive study of the impacts of project activities on all species they are applying for coverage of. The Habitat Conservation Plan will outline avoidance and minimization measures that will be implemented during project activities in order to protect covered species. Finally, the habitat conservation plan will outline mitigation obligations. The applicant must mitigate for all temporary and permit impacts authorized under the habitat conservation plan. The HCP will also describe funding the mitigation; financial arrangements must be made in front of project activities to purchase mitigation lands. This is where integrated vegetation management can be particularly valuable. If a utility can manage and restore lands it has direct impacts on (such as easement lands), there is potential to utilize them as mitigation.

An example of the use of utility right of way easements as mitigation lands was discussed above in the Nation Gird Karner Blue Butterfly case study. The following section will discuss the potential for utility right of ways to be used as mitigation lands by Pacific Gas and Electric Company on PG&E held easements. PG&E has plans to develop multiple habitat conservation plans that will cover all maintenance and operations activities throughout the 70,000 square mile service territory (PG&E, 2014). These management plans will cover 70,000 square miles of utility territory and many threatened and endangered plant and animal species. The opportunity for utility right of ways as mitigation lands is present.

As discussed in the National Grid case study, in house mitigation benefits a utility company through efficiency and cost savings. A utility that is restoring habitat for endangered

species within their right of way will be subject to compliance with the environmental laws that protect those species, should they be present on the right of way. Obtaining a take permit through an HCP can alleviate the utility company's worries surrounding the presence of species on their right of way. A utility company would develop comprehensive avoidance and minimization measures in consultation with state and federal endangered species regulatory agencies prior to approval of an HCP. This relates to the expansion on integrated vegetation management in California by providing an additional benefit to utility companies. Utilizing lands already owned by the company as opposed to purchasing outside mitigation lands can save the company money (as they already need to pay for managing the vegetation within a right of way) as well as provide non-monetary sustainability and environmental stewardship benefits.

6.3 Improved Compliance and Access to Facilities

In addition to the many benefits IVM offers various species, IVM can also provide benefits to the utility company. One of the reasons utilities must maintain clearances in their right of ways is for easy access to their facilities. As discussed in the section on FERC and NERC compliance, utility companies are obligated to conduct visual inspections on their utility lines on a yearly basis. Some of the inspections may be completed by helicopter. This can be more efficient if the power lines are located in terrain with very difficult access or if many miles of line must be covered in a short time. In order to complete aerial surveys, the lines must be visible from the air. This means the vegetation within the right of way is managed effectively and no grow-in is occurring.

In the case of gas right of ways, or underground electric right of ways it is equally important that they be managed. In the event of an emergency, the utility company needs to be able to mobilize to the site quickly and uncover their facilities. If trees or other large plants are growing above facilities, the utility company must first remove it and possibly need to grind the stump. If the tree is large enough, this work could take up to a day and a half to complete. In the event of a gas leak, this is too long. Underground electric facilities are protected from the possibility of making direct contact with vegetation, however like gas lines, vegetation can be a problem for access.

The American Gas Association and utility companies have recently conducted studies into the effects of tree roots on pipelines. The majority of gas pipelines are located underground within a right of way. There has not been as much focus on the vegetation management strategy within these rights of ways compared to the focus on electric right of ways. Recently, utilities and professional organizations, along with researchers have begun looking into the effect tree roots can have pipelines. They have found that when a pipeline is installed it creates a pocket in which soil moisture collects. This pocket of moisture is attractive to the tree roots, which have the job of supplying the tree with water and nutrients. Over time, the tree roots can completely entangle the pipeline (Questar, 2014). This presents an issue for access, as utility workers must dig through the roots then hand remove them from the pipe. The roots can be several inches in diameter and very difficult to remove. The tree roots can also dig into the pipe's protective coating leading to pre-mature corrosion and potential failures (Questar, 2014). Studies are currently under way to evaluate the threat this poses to pipeline integrity.

6.4 Cost Information

Over time, the conversion from incompatible vegetation to low growing plant communities promoted by integrated vegetation management has the potential to be more sustainable than other vegetation management strategies. IVM stresses the conversion of the plant community, rather than continually treating the incompatible vegetation community. Studies conducted by Environmental Consultants Inc. in the 1990's found that the average cost per acre to manage right of ways that have been converted to the early successional stage were almost half of managing those lands that have not been converted. The cost savings come from reduced man-hours and reduced treatment costs (herbicide, tree crews, etc.) (Grayson, 2012). ECI notes that the initial clearing costs can be quite high, but over a period of years the investment is returned. The ECI study also notes that the biggest challenge to vegetation management program managers is unstable funding. Inconsistent funding leads to more emergency response activities than operation and maintenance type activities. This results in neglect of stretches of right of way that will eventually be treated when an outage or other emergency occurs (Grayson, 2012). Since the 2003 blackout, NERC has reviewed the vegetation standards for completion and effectiveness (NERC, 2009). The issues with funding could soon become a thing of the past, as

utilities are now required to submit their Transmission Vegetation Management Plan, including a section on funding to FERC.

It is typically more difficult and expensive to remove mature trees, or large vegetation from the right of way. In the case of gas pipelines, large vegetation can lead to integrity issues and damage to the pipeline. Integrated vegetation management and the stable, low growing, herbaceous plant community it provides can help utility companies keep their right of ways free of incompatible vegetation. In additional to the functional benefits of IVM, there is also evidence that this type of management strategy reduces costs to the utility in the long term, as discussed in previous sections.

Chapter 7. Policy Recommendations

The research conducted on integrated vegetation management by both biological researchers, as well as industry groups has documented the strategy's many benefits. The potential for integrated vegetation management to influence policy can been seen in the National Grid Habitat Conservation Plan example discussed in the case studies section. There is opportunity for California utilities to adopt a similar strategy, as discussed below.

California utilities must be in compliance with state and federal endangered species regulations while conducting various operational activities, including vegetation management. The permitting requirements for compliance with these regulations can pose a significant risk to schedule and can possibly cause the company to miss compliance dates to the CPUC or other regulators. If a utility must obtain coverage for take of an endangered species for a small maintenance activity, the permit could take 6 months or more, or could require the more in-depth and time consuming development of a habitat conservation plan. Developing a Habitat Conservation Plan can mitigate this risk by providing a company with coverage for activities that could impact the species of concern and by eliminating the long lead time of individual permits.

In addition to reducing the time it takes to complete a project which could impact species, the habitat conservation plan coupled with integrated vegetation management could address some concerns with obtaining mitigation lands. As demonstrated in the National Grid HCP example, there could be opportunity to utilize right of way lands as mitigation opportunities. The utility corridors that are owned in fee or otherwise by the utility company would be the easiest

logistically to pursue as mitigation lands. The right of way would already be subject to vegetation management activities and by owning the land the utility could have full control of what happens on the land. If the utility company's IVM program were able to provide habitat for covered species, it could eliminate the need to purchase mitigation credits. This could save the company money as well as the time and effort needed to acquire mitigation credits from a third party vendor.

In additional to providing assistance with the implementation of a habitat conservation plan, there are other policy recommendations which can come out of integrated vegetation management. The North American Electrical Reliability Corporation works with the Federal Energy Regulatory Corporation to develop and approve the vegetation management and other reliability standards that United States electrical transmission owners and operators are subject to. The NERC could study the integrated vegetation management plans implemented by various utilities (and reported to NERC and FERC as part of the FAC-003-2 Transmission Vegetation Management Plan reporting requirements) to evaluate the effectiveness of the strategy. If the study was able to determine that IVM provides the reliability security and benefits that NERC and FERC desire, there is potential to update the transmission vegetation management standards to include some or all of the integrated vegetation management components. This would essentially mandate the comprehensive application of integrated vegetation management on the federal level. NERC and FERC have the authority to oversee and regulate all components of IVM from selecting circuits that should be subject to IVM, to timelines surrounding adaptation of IVM as well as minimum standards or thresholds for compliance. In this scenario, the implementation would be more formalized then the current ANSI300 standards. In addition to formalizing the standards and making them mandatory, the NERC and FERC would be able to implement a non-compliance fining structure.

At the state level, the California Public Utilities Commission could follow a similar path as the NERC and FERC with regards to reviewing the success or integrated vegetation management and adopting the most successful components into the GO 95 Rule 35 and public resource code electric right of way language. California is one of the few states with explicit vegetation management requirements, and is generally a progressive state with regards to environmental regulation (siding on the cautious end of the spectrum). Adaptation of stricter

vegetation requirements, which have a measureable benefit on endangered species would fit in with California's stance on preservation and protection of the state's natural resources.

Other regulatory agencies which could incorporate aspects of integrated vegetation management into their policy recommendations include California Department of Fish and Wildlife and the United States Fish and Wildlife Service. These agencies oversee and administer approval for take of protected species at the state and federal levels. They are responsible for managing and approving mitigation lands. The National Grid HCP case study, as well as any other examples of the utilization of right of way lands as habitat could lend itself to implementation in California. If suitable habitat can be created or developed on site, within the right of way, regulators may want to explore it rather than defaulting to the typical expectation of acquiring mitigation lands through a bank.

The Department and Service could also review examples of implementing integrated vegetation management into habitat conservation plans for consideration in permitting going forward. The proven track record of the benefits of IVM could provide the resource agencies with a strong argument to require utilities to implement it as a condition of permitting.

There are several policy recommendations that can be delivered from the review of integrated vegetation management in California and the country. Regulators at the state and federal level, as resource managers and electric utility mangers, could adapt attributes of the IVM strategy into their regulations and compliance requirements. Resource managers could focus on the species benefits offered by IVM in their mitigation requirements or provisions of take permits, or other resource permits. The case study of utilizing IVM within an HCP could be used as a template for adopting this in California. As mentioned above, HCP's can make permitting for projects much faster and easier than obtaining permits for projects individually, so they are attractive to project proponents (the utility companies).

Federal and state utility regulators are mandated with the task of ensuring system reliability and safety of electric transmission and distribution lines. Integrated vegetation management techniques meet the requirements of vegetation clearance mandates in a sustainable and risk adverse fashion. Integrated vegetation management also offers the opportunity to create or improve upon habitat for rare and endangered species. This management strategy is less invasive over time and is generally a better management strategy for ecosystems. In conclusion, policy recommendations can be made for utility regulators as well as resource managers with a

focus on mandating integrated vegetation management practices into the current utility regulatory portfolio.

Chapter 8. Conclusion

The state of California contains many thousands of miles of utility rights of ways. These rights of ways are located through many different landscape types throughout the state. Managing the right of ways in order to promote safety and reliability has historically been a challenge for utility companies across the country. One of the major challenges is maintaining the vegetation which grows in the utility corridor. Vegetation has been identified as the number one cause of power outages in the country. In addition to outages, vegetation in California's right of ways can pose a fire risk.

California's three largest utility companies; Pacific Gas and Electric, San Diego Gas and Electric, and Southern California Edison manage over 50,000 miles of utility right of ways in the state. Federal and state regulations mandate that every mile of the transmission system be inspected on an annual basis and trees or vegetation growing near the lines be kept at an established minimum distance. The utility companies are required to inventory the trees and vegetation on an annual basis and determine what trimming or removal work is required to stay in compliance. Vegetation management requires a large investment from the companies. Without proper vegetation management, utility companies could face million dollars per day per violation fines from federal regulators. The severity of the fines can pose a risk to the company financially, and must be avoided.

Historically, vegetation management has focused on manual removal of vegetation on a pre-determined cycle, or as emergency response. In the 1950's and 1960's utility companies began integrating herbicide into their vegetation management strategies. This helped to slow the growth of incompatible species and reduce costs. Herbicide was applied generally to the right of way and in volumes that would not be used today. Eventually, land managers and utility companies began to take a more holistic look at vegetation management within the right of ways. The ecosystem based approach that was developed is integrated vegetation management.

Integrated vegetation management incorporates manual removal, selective herbicide application, and the conversion of the incompatible vegetation structure to a low growing, stable, herbaceous plant community. IVM requires a utility company to identify target areas that could be managed in the fashion and to develop a timeline and strategy to implement it (per the reporting requirements of FAC-002-3). This strategy is more time consuming and with higher costs in the early stages, but over time it has shown to be less expensive than traditional methods or emergency response (Caroll, 2010). Converting the vegetation structure within the right of way to low growing herbaceous plants also provides the utility company with some assurance around meeting the minimum compliance distances. Grasses, forbes, and other plants cannot physically pose a threat to encroaching on the lines. The low growing plant structure also allows the utility easy access to their facilities for maintenance or emergency activities.

Case studies of the application of integrated vegetation management have shown that utility right of ways treated with IVM have greater plant diversity and can support various pollinator species including butterflies and bees (Chazen, 2012). This is due to the fact that IVM provides an early successional landscape which would otherwise not be found in the area. The selective removal of competition plants gives the herbaceous plants the opportunity to reclaim the right of way, which would likely not happen without human intervention. In addition to providing habitat, utility right of ways can also be utilized as connective corridors for otherwise isolated islands. Human development in the landscape has created islands of isolated habitat that are disconnected from each other. Utility corridors provide an opportunity to connect these islands. The utility corridors are relatively clear of vegetation and allow for easy movement within them.

California is one of the few states in the western United States that contain serpentine soils and the unique plants that grow in them. Serpentine plant habitat has been lost throughout the state to development. Serpentine endemic plants are low growing, herbaceous, and can provide habitat to various pollinator species. The serpentine soil areas in northern California could be identified for comprehensive implementation of integrated vegetation management. This strategy would have a higher up front cost, but would be cost efficient in the long term through fewer treatment requirements and compliance. Creating habitat would provide utilities with a non-monetary benefit; the ability to meet corporate sustainability and environmental management goals.

Integrated vegetation management provides proven benefits to species and species habitat within the right of way. IVM can also meet the requirements of the federal and state regulations for vegetation clearances around transmission and distribution power lines. The integrated vegetation management strategy can meet the goals and regulatory requirements of utilities and be cost effective in the long term.

Sources:

American National Standards Institute. 2014. ANSI Standards Activities. <http://www.ansi.org/standards_activities/domestic_programs/overview.aspx?menuid=3 Accessed March 29, 2014.

ArcAdvisor. Frequently Asked Questions. < http://www.arcadvisor.com/faq/what_are_shock_approach_boundaries.html> Accessed March 23, 2014.

Barr, Glenn. 2012. Grass Valley Lawsuit Settled. The Mountain News. < http://www.mountain-news.com/news/article_a4cfa5ba-4fbb-11e2-a5f2-0019bb2963f4.html> Accessed March 20, 2014.

Barr, Glenn. 2011. Wildfire Lawsuit Settled. The Mountain News. < http://www.mountain-news.com/news/article_5447e700-eaaa-11e0-84e4-001cc4c002e0.html>. Accessed March 23, 2014.

BASF. 2010. Case Study: Changing Up Right-of-Way Maintenance. Arbor Age. <http://sportsurfonline.com/ME2/Audiences/dirmod.asp?sid=43E91E7F6E244F4C9357F73BE3523C30&nm=News+and+Features&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=DF1548A467D0449381A38E6C405482DF&AudID=AC361F5928F54864BFCBBD93E5B8624D> Accessed January 30, 2014.

Beran, D. 2005. ROW Wildlife Habitat Conservation. Arbor Age 25:14-20.

Bodin, M. 2011. Powerlines as Habitat. Northern Woodlands 70:30-34.

Bracewell and Guiliani. 2009. Overview of NERC Compliance Violations: How to Avoid Repeating Others'Mistakes. Energy Compliance Network. < http://www.bracewellgiuliani.com/assets/dir_docs/news_publication/26b462cd-9535-4021-b8fe-5ab2e8fd14e9_pdfupload.pdf> Accessed March 29, 2014.

Bulluck, L.P., and D.A. Buehler. 2006. Avian use of early successional habitats: Are regenerating forests, utility rights-of-way, and reclaimed surface mines the same? Forest Ecology Management 236:76-84.

California Energy Commission. 2014. About Us. http://www.energy.ca.gov/commission/Accessed March 19, 2014.

California Public Utilities Commission. 2014. About us. http://www.cpuc.ca.gov/PUC/aboutus/> Access March 19, 2014.

California Public Utilities Commission. 2012. CPUC Penalties and Restitution Ordered by CPUC 1999- Feb.21, 2012. < http://www.cpuc.ca.gov/NR/rdonlyres/E36E1107-020F45F6-B85E-20510C76F5B7/0/FinesandRestitution021712.pdf> Accessed March 28, 2014.

California Public Utilities Commission. 2014. Electric System Reliability Annual Reports. < http://www.cpuc.ca.gov/PUC/energy/ElectricSR/Reliability/annualreports/> Accessed March 21, 2014.

California Native Plant Society. 2014. Rare and Endangered Plant Inventory. < http://www.rareplants.cnps.org/result.html?fulldata=serpentine> . Accessed March 23, 2014.

Campbell, J., G. Solomon, G. Fawver, R. Lorello, D. Mathis, C. Quiroga, B. Rhinehart, B. Ward, J. Zaharewicz, and N. Zembillas. 2009. Streamlining and Integrating Right-of-Way and Utility Processes With Planning, Environmental, and Design Processes in Australia and Canada. U.S. Department Of Transportation, Federal Highway Administration. FHWA-PL-09-011. American Trade Initiatives, Alexandria, VA, USA.

Carr, Julie. 2013. Post-2003 Blackout Rules Lead to Millions in Fines. The Big Story. < http://bigstory.ap.org/article/post-2003-blackout-rules-lead-millions-fines> Accessed March 30, 2014.

Chazen Engineering, Land Surveying, and Landscape Architecture CO., P.C., Shoener Environmental Inc., And Kleinfelder, Inc. 2012. Habitat Conservation Plan for the Karner Blue Butterfly and Frosted Elfin. USFWS. Syracuse, NY, USA.

Cieslewicz, S.R., and R. Novembri. 2004. Utility Vegetation Management Final Report. Federal Energy Regulatory Commission. FERC-03AL-30574. CN Utility Consulting, LLC, San Francisco, CA, USA.

Conserve Wildlife Foundation of New Jersey. 2014. New Jersey Endangered and Threatened Species
Field Guide. < http://www.conservewildlifenj.org/species/fieldguide/view/Callophrys%20irus/> Accessed March 10, 2014.

Cost Comparrison of Right-of-Way Treatement Methods: Update 2000. EPRI, Palo Alto, CA and ESEERCO,Schenectady, NY: 2000.1000270.

De Blois, S., J. Brisson, and A. Bouchard. 2004. Herbaceous Covers to Control Tree Invasion in Rights-of-Way: Ecological Concepts and Applications Herbaceous Covers to Control Tree Invasion. Environmental Management 33:606-619.

Doyle, Jim. 1997. PG&E Guilty in 1994 Sierra Blaze/ 739 Counts of Negligience for not Trimming Trees.San Francisco Chronicle. < http://www.sfgate.com/news/article/PG-E-Guilty-In-1994-Sierra-Blaze-739-counts-of-2821364.php#page-2> Accessed March 23, 2014.

Dube, C., S. Pellerin, and M. Poulin. 2011. Do Power Line Rights-of-Way Facilitate the Spread ofNon-Peatland and Invasive Plants in Bogs and Fens? Botany 89:91-103.

Environmental Protection Agency. 2012. Integrated Vegetation Management Fact Sheet. Environmental Protection Agency. <epa.gov/pesp/htmlpublications/ivm_fact_sheet.html>Accessed February 1, 2014.

Federal Energy Regulatory Commission. 2013. Tree Trimming and Vegetation Management. < http://www.ferc.gov/industries/electric/indus-act/reliability/vegetation-mgt.asp>. Accessed: March 21, 2014.

Federal Energy Regulatory Commission. 2013. Revisions to Reliability Standard for Transmission Vegetation Management. 18 CFR Part 40. RM12-4-000, Order No. 777

Finley Engineering Co., Inc. 2010. Cost Analysis for Integrated Vegetation Management Plan. Carroll Electric Cooperative. Berryville, Arkansas, USA.

Forrester, J, D.J. Leopold, and S.D. Hafner. 2005. Maintaining Critical Habitat in a Heavily Managed Landscape: Effects of Power Line Corridor Management on Karner Blue Butterfly (Lycaeides Melissa samuelis) Habitat. Restoration Ecology 13:488-498.

Golden Gate National Parks Conservancy. 2014. Mission Blue Butterfly. http://www.parksconservancy.org/conservation/plants-animals/endangered-species/mission-blue-butterfly.html. Accessed: April 26, 2014.

Green, J.D., J.R. Hartman, M.P. Johnson, J.E. Primus, D.L. Spatcher, and W.C. Wheeler. 1996. Training Manual For Right-of-Way Vegetation Management. US Department of Agriculture. PAT-1-6. Cooperative Extension Service, Lexington, Kentucky, USA.

Greenfield, Lawrence R. 2010. An Overview of the Federal Energy Regulatory Commission and Federal Regulation of Public Utilities in the United States. < http://www.ferc.gov/about/ferc-does/ferc101.pdf>. Accessed March 23, 2014.

Grayson, Lynn. 2012. UAA Best Management Practices for Funding. Utility Arborist AssociationBestManagementPractices .<http://www.utilityarborist.org/research/resources/fundingWP.pdf>Accessed March 28, 2104.

Harriman, J., and D. Baker. 2003. Applying Integrated Resource and Environmental Management toTransmission Right-of-way Maintenance. Journal of Environmental Planning and Managemen t46:199-218.

Haugen, D. 2013. Trees vs. transmission. Utility arborist group seeks better approach. Midwest Energy News. <http://www.midwestenergynews.com/2013/08/19/trees-vs-transmission-utility-arborist-group-seeks-better-approach/> Accessed January 30, 2014.

Lehnsu, T., A. Komomnen, O. Hiltula, J. Paivinen, V. Saari, and J. Kotiaho. 2011. The role of power line Right-of-way as an alternative habitat for declined mire butterflies. Journal of Environmental Management 92:2539-2546.

Macek, N. M. 2006. Right-of-Way and Environmental Mitigation Costs- Investment Needs Assessment. American Association of State Highway and Transportation Officials. NCHRP Project 20-24(54)B. Arlington, Virginia, USA.

Marshall J.S., and L.W. Vandruff. 2002. Impact of Selective Herbicide Right-of-Way Vegetation Treatment on Birds. Environmental Management 30:801-806.

Mitchell, Joseph. 2009. Powerlines and Catastrophic Wildland Fires in Southern California. <http://www.mbartek.com/FM09_JWM_PLFires_1.0fc.pdf> Accessed March 23, 2014.

Money, Nelson. 2013. Utility IVM: Past, Present, and Future. Dupont. < http://www.dupont.com/content/dam/assets/industries/agriculture/assets/cp_A-194_UtilityIVM_TDW_UAA_June2013.pdf> Accessed March 28, 2014.

National Grid. 2009. Five Year Vegetation Management Plan 2009-2013. < http://www.nationalgridus.com/non_html/National_Grid_VMP_2009-2013.pdf> Accessed March 25, 2014.

Nekola, J. 2012. The Impact of a Utility Corridor on Terrestrial Gastropod Biodiversity. Biodiversity and Conservation 21:781-195.

New York State Department of Environmental Conservation. 2010. Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits. Environmental Conservation Law S. 11-0535.

North American Electric Reliability Corporation Vegetation Management Standard Drafting Team.
2009. Transmission vegetation Management NERC Standard FAC-003-2 Technical Reference. North American Electric Reliability Corporation. FAC-003-2. NERC, Princeton,NJ, USA.

North American Electrical Reliability Corporation. 2012. NERC Operating Manual. NERC, Atlanta,Georgia, USA.

North American Electrical Reliability Corporation. 2006. FAC-003-1 Transmission Vegetation Management Program.

Nowak, C.A., L.P. Abrahamson, E.F. Neuhauser, C.G. Foreback, H.D. Freed, S.B. Shaheen, and C.H. Stevens. 1992. Cost Effective Vegetation Management on a Recently Cleared Electric Transmission Line Right-of-Way. Weed Technology 6:828-837.

Orange and Rockland Utilities, Inc. 2012. Transmission Vegetation Management Plan. < http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={EAF11CA2-3C00-4EA9-954D-BFFE74E78F0E}>. Accessed March 28, 2014.

Oregon Department of Transportation. 2011. Integrated Vegetation Management Program. < http://www.oregon.gov/ODOT/HWY/OOM/docs/ivm_program_summary.pdf> Accessed March 29, 2014.

Owens, K. 1999.The Right Way to Vegetation Management. Pesticides and You. 19:9-17.

Pacific Gas and Electric Company. 2014. Company Profile. Pacific Gas and Electric Company. <http://www.pge.com/en/about/company/profile/index.page.> Accessed February 20, 2014.

Pacific Gas and Electric Company. 2014. Habitat Conservation Plan. <http://www.pge.com/about/environment/pge/stewardship/habitatconservationplan.shtml Accessed: March 15, 2014.

Pacific Gas and Electric Company. 2014. 2013 Annual Electrical Reliability Report (D.96-09-045 And D.04-10-034).

Pacific Gas and Electric Company. 2014. Laws and Regulations. < http://www.pge.com/myhome/customerservice/other/treetrimming/lawsregulations/> Access March 19, 2014.

Pacific Gas and Electric Company. 2012. Annual Report. 1: 1-436.

Public Service Commission of Wisconsin. 2013. Right-of-Ways and Easements for Electric Facility Construction. Public Service Commission of Wisconsin, Madison, Wisconsin, USA.

Public Service Commission of Wisconsin. 2013. Electric Transmission Lines. Public Service Commission Of Wisconsin, Madison, Wisconsin, USA.

Public Utilities Commission of the State of California. 2007. Rules for Construction of Overhead Electric Line Construction, General Order 95.

Questar. 2014. https://www.questargas.com/brochures/59090.pdf. Accessed: April 26, 2014.

San Diego Gas and Electric Company. 2014. Electric System Reliability Annual Report, 2013.

San Diego Gas and Electric Company. 2009. Direct Testimony of Dan Akau San Diego Gas and Electric Company (Rice Fire). < https://www.sdge.com/sites/default/files/regulatory/Akau%20Testimony-Final.pdf> Accessed March 26, 2014.

San Diego Gas and Electric Company. 2010. General Rate Case, 2012.

Scientific American. 2008. The 2003 Northeast Blackout- Five Years Later. < http://www.scientificamerican.com/article/2003-blackout-five-years-later/>. Accessed March 24, 2014.

Shepherd, B., and J. Whittington. 2006. Response of Wolves to Corridor Restoration and Human Use Management. Ecology and Society 11:403-417.

Smallidge, P.J., Leopold D.J., and Allen C.M. 1996. Community Characteristics and vegetation Management of Karner blue butterfly (Lycaeides Melissa samuelis) habitats on Right-of-way in east-central New York, USA. Journal of Applied Ecology 33:1405-1409.

Southern California Edison. 2014. Annual System Reliability Report, 2013.

Southern California Edison. 2012. Southern California Edison Backgrounder. Southern California Edison Corporate Communications, CA, USA.

Southern California Edison. 2013. 2015 General Rate Case Application, Workpapers. Transmission And Distribution Maintenance SCE-03 6:1-162.

State of California. 2012. Rules for Overhead Electric Line Construction, General Order 95.

Tamasovic, Brian S. 2011. A High-Voltage Conflict on Blackacre: Reporting Utility Easement Rights For Electric Reliability. Journal of Environmental Law 1:1-57.

Transmission Forestry Strategy. 2010. Transmission Right-of-Way Management Program. National Grid, Waltham, Massachusetts, USA.

US Fish and Wildlife Service National Conservation Training Center. 2011. Managing Utility Rights-of-Way For Wildlife Habitat A Self Study Guide. US Fish and Wildlife Service. 1018-0115. US Fish and Wildlife Service National Conservation Training Center, Sheperdstown, West Virginia, USA.

Yahner, R. H., R.T. Yahner, and R.J. Hutnik. 2007. Long-Term Trends in Small Mammals on a Right-of-Way in Pennsylvania, U.S. Arboriculture and Urban Forestry 33:147-152.

Yahner, R. H., R. T. Yahner, and B. D. Ross. 2008. Plant Species Richness on a Transmission Right-of-Way In Southeastern Pennsylvania, U.S. Using Integrated Vegetation Management. Arboriculture and Urban Forestry 34:238-244.

Yahner, R.H. and R.J. Hutnik. 2005. Integrated Vegetation Management on an Electric Transmission Right-of-Way In Southeastern Pennsylvania, USA. Journal of Aboriculture 31(5): 263-269.