Quantification of Lewis's Woodpecker habitat using Forest Inventory and Analysis data

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***ABSTRACT**: The Utah Department of Natural Resources' Division of Wildlife Resources (UDWR) placed Lewis's Woodpecker (Melanerpes lewis) on their Sensitive Species Tier II list due to declining populations and suspected local extirpations throughout the state. It is thought that the decline in burned coniferous forest has reduced the amount of suitable habitat for these birds, which are known to be closely tied to disturbed landscapes. The UDWR has identified several key components of Lewis Woodpecker habitat using an Ecological Integrity Table (EIT). An EIT identifies "key ecological attributes" such as breeding habitat, food, and their acceptable range of variation as measured by selected indicators. The main indicators for Lewis's Woodpecker breeding habitat were identified as plant association (i.e. forest type), tree canopy cover, and number of suitably-sized snags per hectare of habitat. Each of these indicators is measured in some fashion by FIA crews on every visited phase 2 forested plot. The indicators and their FIA surrogates were used in this analysis to quantify breeding habitat that occurs within and outside of Lewis's Woodpecker's preferred habitat of burned coniferous forests in Utah. We produced area estimates for each indicator thought to be important to Lewis's Woodpecker as well as estimates of forest land that provide all of the structural components in concert. We demonstrated the utility of FIA data for large scale habitat evaluation, identifying limiting attributes, and as a monitoring tool for habitats of sensitive species that use forested landscapes at some point of their life history.*

KEYWORDS: Lewis's Woodpecker, *Melanerpes lewis*, breeding habitat, FIA, monitoring, ecological integrity table

Introduction

Lewis's Woodpecker (*Melanerpes lewis*) occurs throughout western North America where open "park-like" forest stands or recent burns predominate and provide structure that facilitates the bird's mating and foraging strategies (Bock 1970, Sousa 1983, Tobalske 1997). A preference for burned areas has resulted in the species being categorized as a "burn specialist" (Bock 1970, Raphael and White 1984, Block and Brennan 1987, Saab and Vierling 2001). Large numbers of dead and decaying trees, presence of woody ground cover, and open canopy and sub-canopy found in burned pine forests are ideal for this species (Linder and Anderson 1998, Russell et al 2007, Saab et al 2007). Fire suppression policies over the past century have reduced the extent of burned forest landscapes in the

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Intermountain West. This has resulted in a decline in preferred habitats of Lewis's Woodpecker. However, some unburned ponderosa pine, cottonwood, and aspen stands have been found to provide suitable structure and are used successfully by the bird (Medin and Clary 1991, Tobalske 1997, Vierling 1997, Linder and Anderson 1998, Saab and Vierling 2001). While the use of burned areas by this species has been well documented in some forest types, the qualitative nature of undisturbed forest structure used by Lewis's Woodpecker is still largely unknown, particularly in aspen stands. Although use of ponderosa pine is not uncommon, use of aspen habitats has not been well documented in Utah. From management and census perspectives it is important to know the potential of alternate habitats to provide suitable breeding sites for these birds, given the relative scarcity of recently burned forests in Utah (Figure 1).

The Utah Department of Natural Resources' Division of Wildlife Resources (UDWR) placed Lewis's Woodpecker on the Utah Sensitive Species Tier II List due to declining populations throughout the state as well as suspected local extirpations (Behle et al 1985, Sorenson 1986, Parrish et al, 1999, UDWR 2007). Herein we explore the utility of the Forest Inventory and Analysis (FIA) program of the U.S. Department of Agriculture Forest Service as an accounting and monitoring tool for forest species habitat in Utah. We use potential breeding and foraging habitat in undisturbed (not burned or cut) forests for Lewis's Woodpecker as a test case.

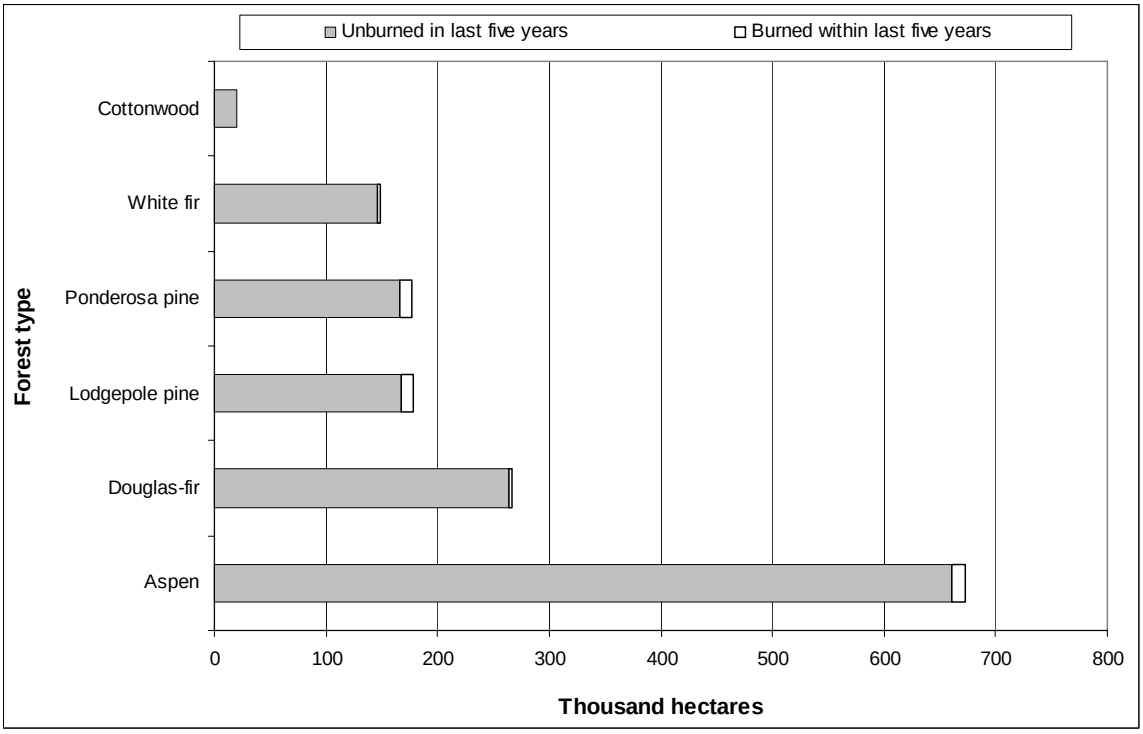

Figure 1: Estimated burned and unburned area of various forest types in Utah. Plots classified as burned have done so within five years of the field crew visit.

Forest Inventory and Analysis Data

FIA is responsible for assessing the status and trends of all forested lands in the U.S. (Gillespie 1999). FIA conducts inventory on all forested lands of the U.S. using a nationally standardized plot design at an intensity of approximately 1 field plot per 2,388 hectares (USDA 2007). The Interior West region of FIA (IW-FIA) is responsible for data collection and analysis in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.

In 2000, IW-FIA implemented a continuous annual inventory system (Gillespie 1997). Under annual inventory, approximately 10 percent of plots from the full sample set in a state are measured each year. Plots belonging to an annual panel are distributed evenly across each state so as to be free of geographic bias. States have been gradually phased into the annual system (Utah, 2000; Arizona, 2001; Colorado, 2002; Idaho, 2003; Montana, 2003; New Mexico, 2008), increasing geographic coverage of the Interior West over the past 8 years. Nevada partially employed the annual plot system in 2004 and 2005.

IW-FIA field crews measure and document well over one-hundred plot, condition and tree variables on forested plots. Many of these variables are "national core" variables and are collected in a consistent manner across all regions of the United States. IW-FIA also has several variables that are collected using protocols specific to IW-FIA in order to serve local needs and interests. Some of these variables are used in our analysis as well. For this analysis we used data gathered using annual inventory protocols in Utah during 2000-2006.

Methods

The UDWR has identified several key habitat components of Lewis's Woodpecker in Utah using an Ecological Integrity Table (EIT) (Oliver 2009). An EIT identifies "key ecological attributes", such as breeding habitat and food, and their acceptable range of variation as measured by selected indicators (Parrish et al 2003, UDWR 2005).These tables have been compiled for each species listed in the Utah Comprehensive Wildlife Conservation Strategy (Sutter et al. 2005). The primary indicators for Lewis's Woodpecker breeding habitat were identified as plant association (Bock 1970, Tobalske 1997, Saab and Vierling 2001), tree canopy cover, and number of suitably-sized snags per hectare of habitat (Sousa 1983). The primary indicator for Lewis's Woodpecker foraging habitat was percent cover of woody understory (Sousa 1983, Tobalske 1997). Each of these indicators is measured in some fashion by FIA crews on every visited forested plot. The indicators and their FIA surrogates used in this analysis are listed along with a brief description of methodologies used to acquire the data in table 1. In addition to the IW-FIA variables used to quantify habitat for Lewis's Woodpecker, data collected on land ownership are analyzed for the purposes of discussing where potential Lewis's Woodpecker habitat occurs in Utah and what

management potential exists. A detailed description of IW-FIA field protocols and definitions can be found in USDA (2007).

TABLE 1: Name and definition of habitat indicators from UDWR Ecological Integrity Table for Lewis's Woodpecker, along with their associated FIA variables and a basic description of how they are collected on the plot. Detailed protocols for collecting IW-FIA field data can be found in USDA 2007**.**

Key Ecological Attribute	Description	FIA surrogate	How measured
Plant Association	Major vegetation class. The two best rankings include ponderosa pine, aspen, cottonwood, disturbed pine, and pine or fir types that can provide open areas between the canopy and understory for foraging. Oak woodlands are identified as preferred winter habitat but not included in breeding habitat.	*Forest Type*	Calculated by algorithms using the plurality of stocking of all live trees tallied on the plot.
% Tree Canopy Cover	Percent of ground shaded by vertical projection of canopies of woody vegetation > 5 m in height.	*Crown Cover*	Measures crown intercept of live trees 2.54 cm or greater diameter at breast height (DBH) on every foot of four 7.62 meter long transects originating from the center of each subplot and running in each of the four cardinal directions.
% Shrub Crown Cover	Percent of ground shaded by vertical projection of canopies of woody vegetation < 5 m in height.	*Tree Cover-Aerial View* and *Shrub Cover-Aerial View*	Ocular estimate to the nearest 1% of the total canopy cover of trees < 2.54 cm DBH on each subplot. The same is done with shrub cover, and then the total cover of small trees and shrubs is added and averaged over the entire plot.
Number of Snags Per Hectare	Number of standing dead trees at least 30.48 cm DBH and 9.14 meters tall per hectare of otherwise suitable habitat.	*Status Code, Lean Code, Actual Height, and Diameter*	*Status Code* records whether the tree is alive or dead, Lean Code records whether the snag is standing at an angle <> 45%, Actual Height records the physical height of the tree, and Diameter records the diameter of the snag at "breast height" (1.37 meters).

The range of each EIT variable is divided into four "Indicator Ratings" ranging from "poor" to "very good". The breaks between each rating are based on available published and professional knowledge of the species. The Lewis's Woodpecker EIT documents some disagreement in the literature concerning the amount of woody understory that is needed to be considered optimal habitat. We report on both of the proposed ratings here. The EIT also acknowledges that although good crown cover for Lewis's Woodpecker is thought to be less than 53 percent, extremely low or the absence of crown cover may not be ideal for the species. Given this ambiguity and the fact that IW-FIA collects the majority of their data on plots with 5 percent or greater canopy cover, we defined a crown cover of 5-52 percent to represent suitable habitat. In consideration of the plant association indicator, those lands described as "non-stocked" by FIA standards were included in the area estimates as long as the field-derived forest type agreed with the EIT definition. Non-stocked lands are those that formerly supported forests but do not have the requisite cover or stocking to be classified to a forest type using the FIA algorithm. More often than not, these lands have been subject to fire, harvest, disease, or other disturbance(s) and likely will re-develop into the field-identified forest type at some point in the future through natural regeneration or plantings. While Figure 1 illustrates the estimated hectares of burned forests in Utah, all estimates provided hereafter will contain all non-stocked hectares regardless of disturbance type.

For this analysis, we considered variable measurements that fell within the two best ratings for each indicator to represent suitable habitat for Lewis's Woodpecker. These indicator rankings are shown in Table 2. An exception to this was snag densities, where IW-FIA methodologies only describe densities equal to or greater than about 2.4 snags per hectare. In order to account for the estimated area with snag densities from .2 - 2.3 snags per hectare, a model,

$$(y = 1/(a + bx^c)$$

was fit to a scatter plot of number of plots in a given forest type versus number of snags recorded on the plot. In this model y is the number of conditions that were estimated to have between .2 and 2.3 snags per hectare, a, b, and c were estimated parameters of the curve, and x was the number of snags tallied on the condition.

The extension of the curve below 2.4 snags per hectare gave a good fit (r^2 = 0.766) and resulted in an upward adjustment of 14 percent for all softwoods and a nine percent adjustment for the aspen forest type. These adjustments are reflected in the final estimates of area satisfying snag density thresholds.

The IW-FIA data for Utah collected in 2000-2006 were queried and plots identified that met each of the rating thresholds. Expansion factors were assigned to each plot and by summing the plots that met each criterion, a state-wide estimate of hectares was produced. All data compilations and summary statistics

were performed using SAS software (Ver. 8.02, SAS Institute, Cary, NC). All estimates expressed in percentages were rounded to the nearest whole percent.

TABLE 2: Indicators of "Key Ecological Attributes" and their qualitative ratings from the Utah Division of Wildlife Resources' Ecological Integrity Table for Lewis's Woodpecker. Oak woodlands and nut and fruit orchards are not considered important breeding habitat and were excluded from this analysis.

Indicator	"Good" and "Very Good" Rating
plant association	oak woodland, nut and fruit orchards, pine-fir, ponderosa pine, cottonwood or aspen riparian, logged or burned forest
% tree canopy cover	$\leq$ 52%
% shrub crown cover < 5 m in height	$\geq$ 25%
% shrub crown cover < 5 m in height	$\geq$ 13%
number of snags $\geq$ 30.5 cm DBH and $\geq$ 9.1 m tall per ha	> 1.25

Results

Forest type

The amount of forest land in Utah potentially suitable for Lewis's Woodpecker was estimated at 1,504,111 hectares, or almost 19 percent of all forested lands in Utah (Figure 2). Of the forest types included in the highest indicator rating for this Key Ecological Attribute, aspen contributed the most acreage, with estimates exceeding 672,000 hectares. This accounts for approximately 45 percent of the total estimated suitable acreage in this indicator. The next highest contribution was from Douglas-fir, which approached 18 percent of the acreage at 266,253 hectares.

Crown cover

An estimated 867,343 hectares met both the requisite crown cover and stocked forest type criteria for Lewis's Woodpecker (Figure 3). This accounted for roughly 57 percent of the land estimated to be suitable for Lewis's Woodpecker in terms of stocked forest type. Aspen contributed more to this acreage than any two other forest types combined at approximately 323,543 hectares or roughly 38 percent of the total (Figure 4).

Woody Cover

The amount of suitable stocked forest with adequate crown cover that meets or exceeds the woody cover greater than 25 percent woody understory threshold was estimated to be 417,979 hectares (Figure 5). Aspen accounted for nearly half of this total with an estimated 206,018 hectares. Douglas-fir was the second-most abundant forest type meeting the 25 percent woody cover threshold at 76,987 hectares. The estimate of otherwise suitable habitat that only meets the woody cover greater than 13 percent threshold for woody understory was 686,905 hectares. Aspen forests again provided the bulk of this estimate at 269,442 hectares. Douglas-fir was the next biggest contributor when the woody understory threshold was dropped to 13 percent, providing approximately 123,536 hectares.

Snag Densities

An estimated 122,927 hectares in Utah have adequate snag densities while also meeting the requirements of forest type, crown cover, and woody cover greater than 25 percent (Figure 6). This estimate increased to 222,242 hectares when woody cover greater than13 percent was considered. The aspen forest type provided the majority of the acreage with 44,731 hectares at a woody cover greater than 25 percent threshold and 64,936 hectares at the woody cover greater than13 percent break. Lodgepole pine was the second greatest contributor when woody cover greater than25 percent was considered, while White fir got this distinction when the woody cover greater than13 percent criteria is applied.

Ownership

Figure 7 shows distribution of area that met forest type, crown cover, and woody cover greater than 13 percent thresholds for Lewis's Woodpecker by major ownership groups. Based on our assessment, the Forest Service manages roughly 71 percent of the potential breeding habitat of Lewis's Woodpecker in Utah. The bulk of remaining area is under private ownership, including almost 30 percent of the aspen predicted to be suitable habitat.

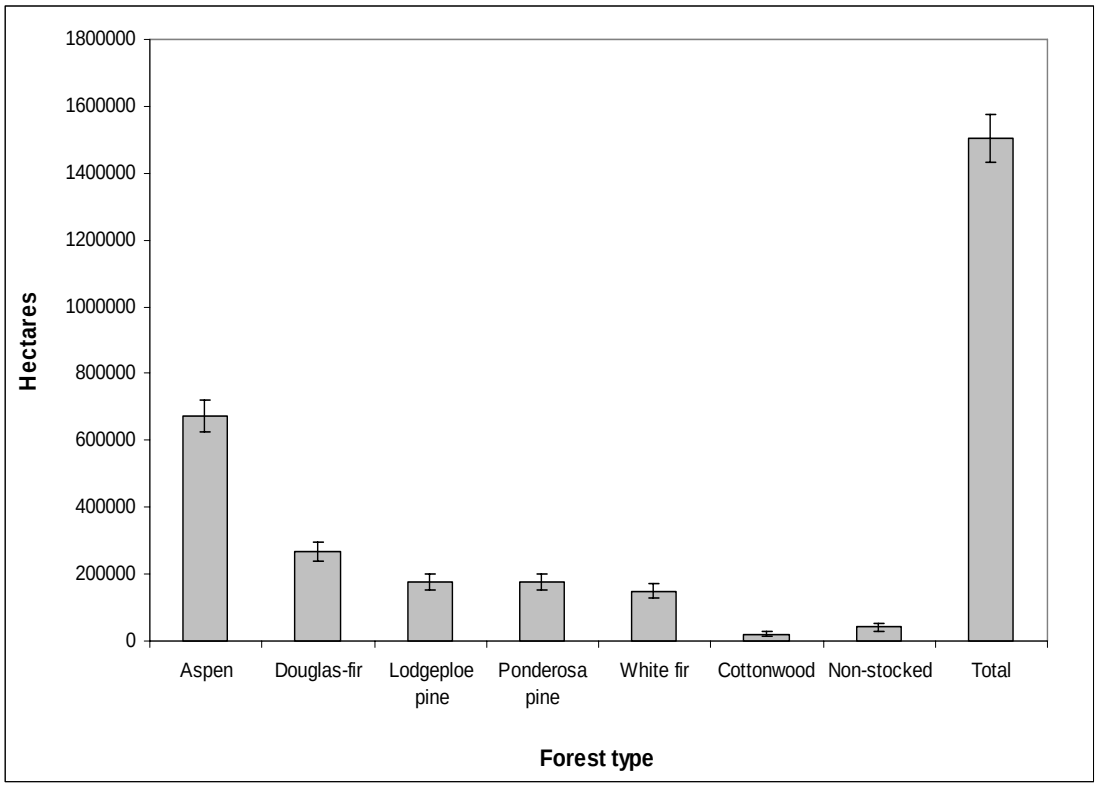

Figure 2: Estimated area of forest land in Utah by FIA forest types thought to be potentially useful to Lewis's Woodpecker for breeding and nesting purposes. Error bars represent the ninety-five percent confidence interval for the estimate.

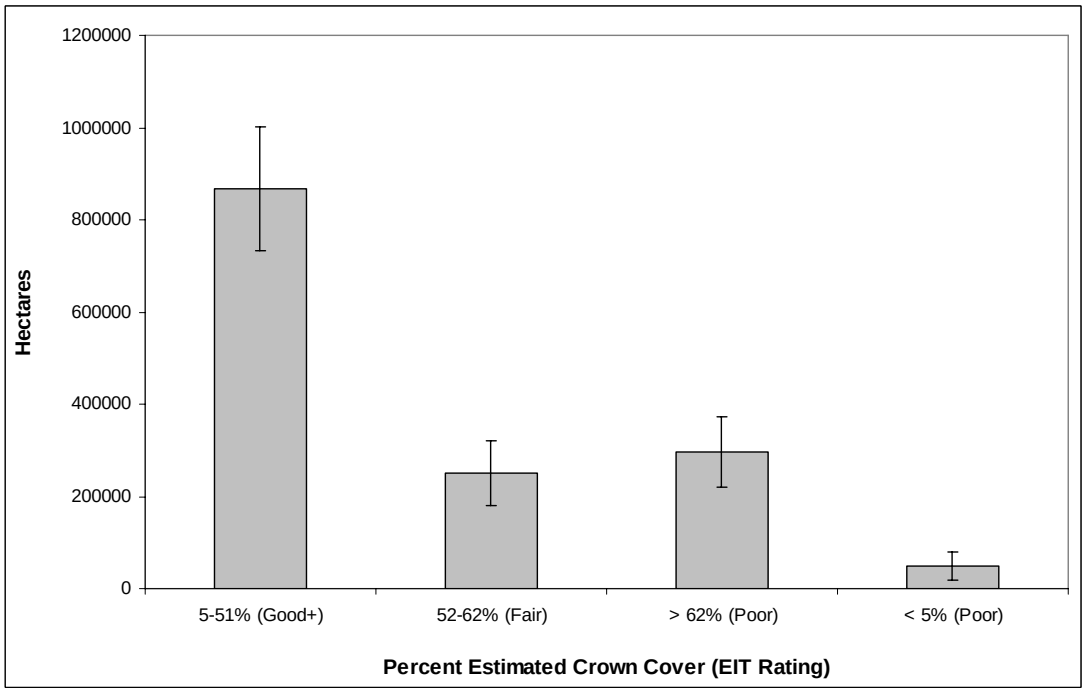

Figure 3: Estimated area of forest land in Utah by forest type and crown cover ratings. Error bars represent the ninety-five percent confidence interval for the estimate.

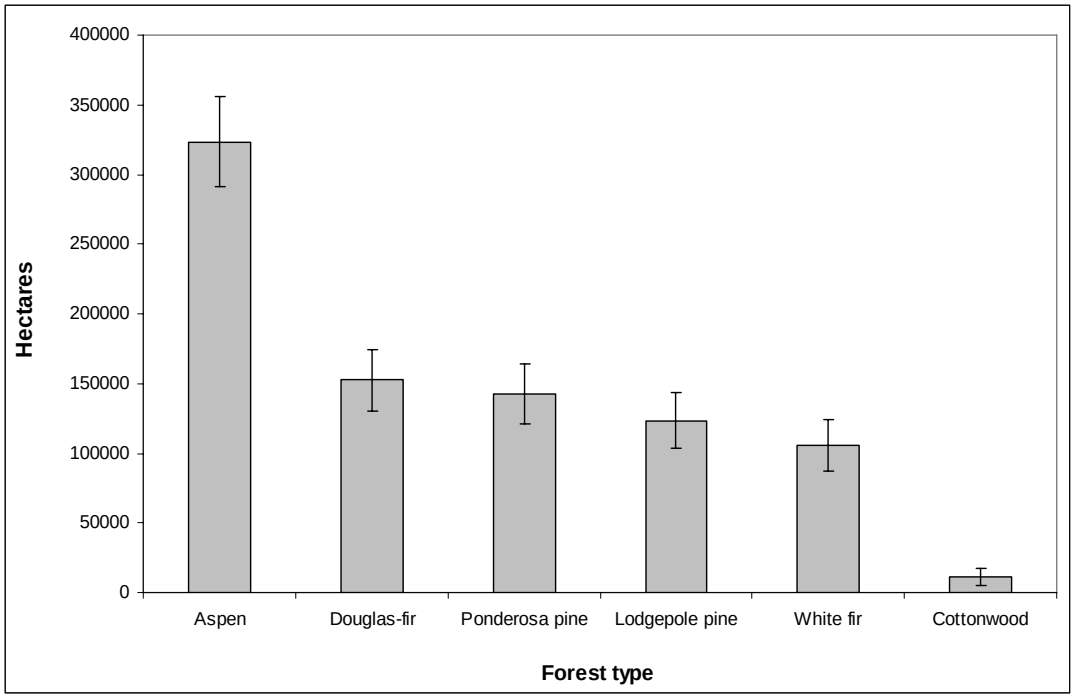

Figure 4: Estimated area of forest land in Utah that meets forest type and crown cover thresholds thought to be useful to Lewis's Woodpecker for breeding and nesting purposes. Error bars represent the ninety-five percent confidence interval for the estimate.

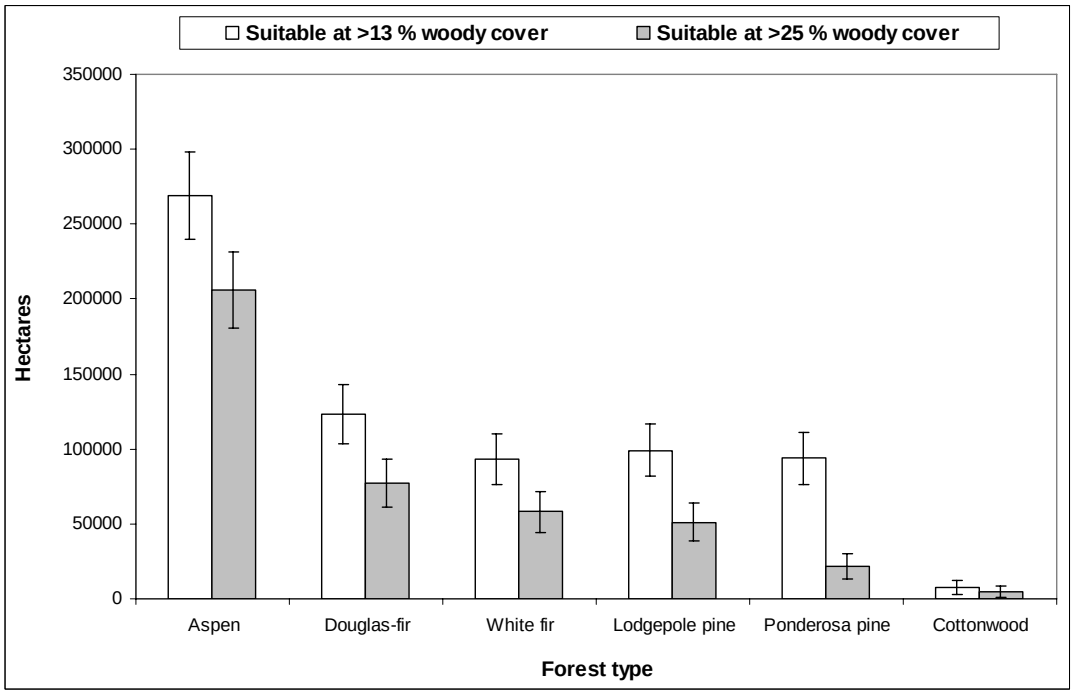

Figure 5: Estimated area of forest land in Utah that meets forest type, crown cover, and woody understory cover thresholds thought to be useful to Lewis's Woodpecker for breeding and nesting purposes. Error bars represent the ninety-five percent confidence interval for the estimate.

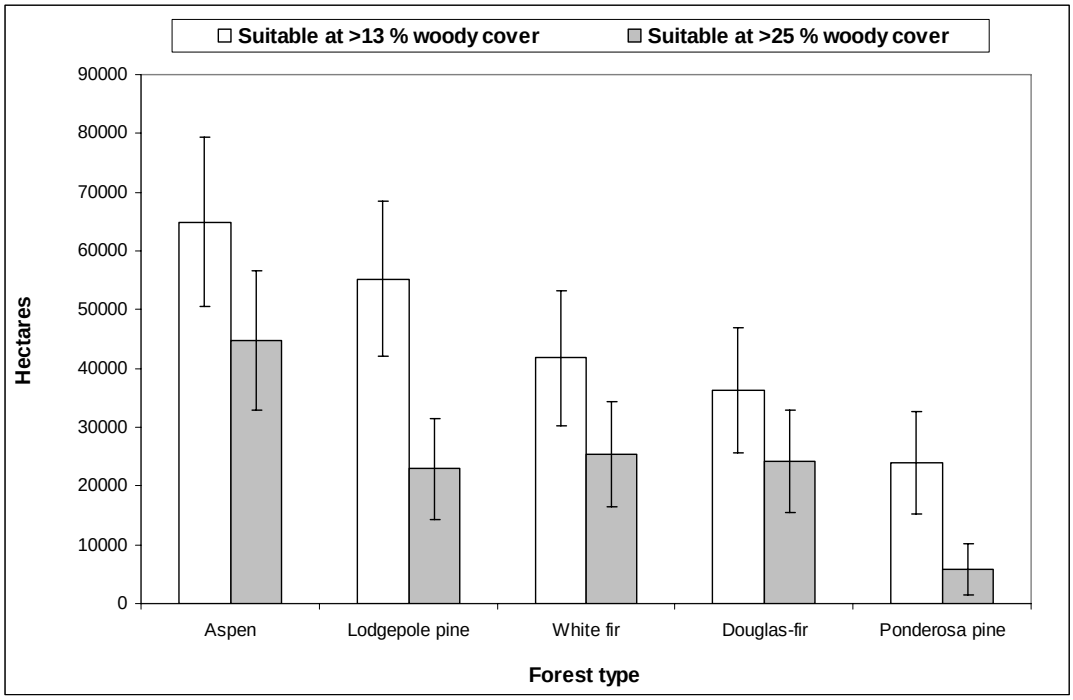

Figure 6: Estimated area of forest land in Utah that meets forest type, crown cover, woody understory cover, and snag density thresholds thought to be useful to Lewis's Woodpecker for breeding and nesting purposes. Error bars represent the ninety-five percent confidence interval for the estimate.

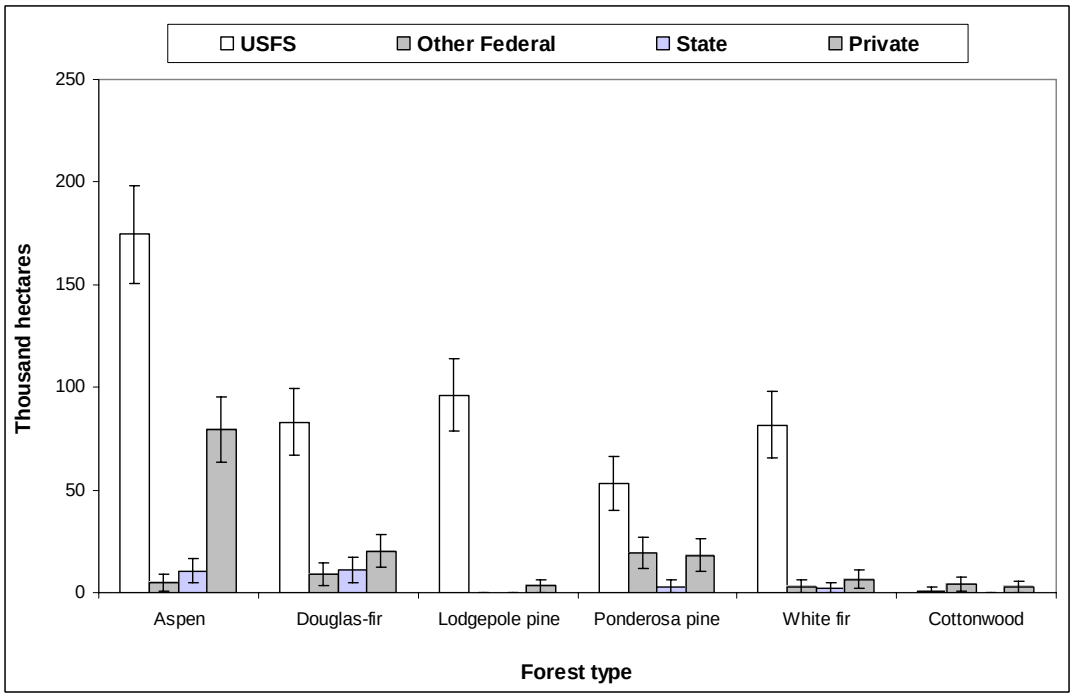

Figure 7: Estimated area of forest land in Utah that meets forest type, crown cover, woody understory cover, and snag density thresholds by land ownership. Error bars represent the ninety-five percent confidence interval for the estimate.

Discussion

The EIT for Lewis's Woodpecker was assembled using the best available published research and local knowledge of the species' ecology. However, research on the species in non-disturbed forests is relatively scarce, and peer-reviewed literature on the species in Utah is very sparse. Consequently, the EIT documents some disagreement in the literature concerning the amount of woody understory that is needed to be considered optimal habitat in Utah. It is not fully known whether Lewis's Woodpecker use Utah's landscape in the same manner as in other parts of their range where they have been observed or studied more intensely. The IW- FIA data presented here suggest that suitable habitat in Utah may be provided by forest types not strongly linked to Lewis's Woodpecker in the literature (Bock 1970, Diem and Zeveloff 1980, Sousa 1983, Vierling 1997, although see Medin and Clary 1991, Neel 1999 and Newlon 2005), although more study may be needed to verify this. In addition, how often Lewis's Woodpecker uses lodgepole pine stands for nesting sites is not well known. FIA data suggest the potential exists for this type to provide the structure these birds are thought to prefer. If they do utilize this resource, the lodgepole pine forests of the Uinta Mountains could provide approximately 99,134 hectares of potential habitat, giving it local importance if not statewide value. Additionally, there are several Douglas-fir stands that co-occur in the Uinta Mountains that scored high in the indicator ratings. These two forest types make up 64 percent of the potential habitat in the Uinta Mountains yet are not strongly associated with Lewis's Woodpecker in the literature.

The results indicate that when both canopy cover and woody understory cover are considered, aspen and Douglas-fir forest types provide the bulk of the preferred structure thought to be important for Lewis's Woodpecker for nesting and feeding activities outside of winter. Ponderosa pine, thought to be the most important forest type other than burned pine forests and cottonwood for these birds during the breeding season (Tobalske 1997), provides less than half the potential habitat that aspen does. When snag densities are considered much of the aspen acreage appears to be unsuitable. However, snag presence should not be as important in aspen types because of the ease of excavation of live aspen trees, the abundance of live trees with diseased portions of the bole, and the number of other excavating bird species that use aspen regularly and create new cavities annually (Dobkin et al, 1995, Daily 1993, Flack 1976). For these reasons, any aspen forest that meets the crown cover and woody cover requirements could be considered potentially suitable habitat.

Tobalske (1997) attributes declining Lewis's Woodpecker populations to the loss of burned stands and riparian cottonwood habitats. This conclusion is supported by the paucity of estimated burned forest land and cottonwood that has the present or future potential to support Lewis's Woodpecker in Utah. However, if the structural preferences of Lewis's Woodpecker are accurately reflected in the EIT, suitable habitat for this species may abound in Utah's unburned aspen

forests. Newlon (2005) showed high reproductive success and survivorship in riparian aspen communities in Idaho and suggested that these communities may provide better overall nesting habitat than do cottonwood forests. This is an important consideration as many land managers and researchers are concerned about the state of aspen throughout the Intermountain West. The same fire suppression activities that have been implicated in reducing availability of traditional habitats for this species may be the inadvertent architect of new habitats in aspen stands as lack of fire in aspen may result in dense canopies, less sub-canopy structure, and a shrubby understory where canopy breaks exist. Current and proposed efforts to convert aspen to younger stands/earlier seral stages in Utah could have both positive and negative effects to Lewis's Woodpecker breeding habitat. Treatments in stands with little or no understory could increase shrub and seedling cover, making it more productive for breeding birds. However, treatments in stands already providing sufficient habitat components would have negative consequences for Lewis's Woodpecker, especially if ponderosa pine and other traditional habitats are not managed in conjunction with aspen "restoration" efforts. It is also important to note that while aspen contributes relatively little to the total forested landscape in the Intermountain West, it is the fourth most common forest type in Utah, trailing only the pinyon-juniper, juniper woodland, and oak woodland types, respectively (USDA, unpublished data). These three woodland forest types are thought to provide very little breeding habitat for Lewis's Woodpecker because they lack the structure that provides good flycatching opportunities, and in the case of the pinyon-juniper and juniper woodland types, they often lack the desired woody understory component (Bock 1970).

There is some uncertainty regarding how much understory vegetation is required to meet the needs of Lewis's Woodpecker (Block and Brennan 1987, Tobalske 1997). It has been suggested that a certain amount of woody cover is required to support the invertebrate communities these birds depend on during breeding season (Bock 1970, Sousa 1983). However, the amount of woody understory necessary may vary by the general forest type selected and its association with riparian systems, agricultural fields, and oak stands. One could also argue that because of the ephemeral nature of insect availability in general, the understory structure directly surrounding the nest tree may not be as important as the nest's proximity to the aforementioned resources. The amount of understory the species requires is an important consideration in Utah, especially as it pertains to ponderosa pine. If woody cover of at least 25 percent is indeed what is required, the estimated amount of predicted suitable ponderosa pine habitat is reduced by roughly 76 percent. Estimates for suitable lodgepole pine are reduced by approximately 59 percent.

No information could be found documenting the foraging range of Lewis's Woodpecker around its nest. Block and Brennan (1987) suggest unburned stands of Jeffrey pine and Douglas-fir in California adjacent to burned areas are used for foraging after nesting season (e.g. after August 1). No nests or individuals were

observed in unburned stands prior to that time period. In addition, while the mean shrub cover of unburned areas used for nesting was 13.4 percent, unburned sites averaged 26.5 percent. These results conflict with the recommendations in Sousa (1983) and agree more closely with other published reports of successful breeding in areas with woody understory cover ranging from as low as 6.7 percent up to 13 percent 13 percent (Medin and Clary 1991, Linder and Anderson 1998).

The extent of the effects of temporal availability of resources between burned and unburned sites on foraging behavior has not been studied. There also may be behavioral traits that restrict adults to foraging in close proximity to their nests until their young have fledged. If insects and other food resources were available in both burned and unburned areas concurrently, nests constructed near the edge of these cover types would have facilitated adult foraging in the unburned areas while maintaining a close proximity to their unfledged young. The fact that no individuals were observed in the unburned stands while the nesting season was in process suggests some behavioral reluctance to venture into these areas. However, distance from nest tree to unburned stands was not reported by Block and Brennan (1987).

Although beyond the scope of this analysis, several FIA variables such as quadratic mean diameter, stand density index, and basal area may prove useful in refining the physical and spatial description of a plot such that other important components could be identified and quantified. The EIT assumes that all "pine-fir" forests have potential to provide habitat to the species, but it is doubtful that all of the types that could be considered pine-fir would provide such structure. In Utah it appears to be rare in the subalpine fir and spruce-fir forest types if anecdotal information reflects the general condition. Regardless of the potential of certain types to exhibit the sub-canopy space needed for flycatching, having variables that actually reflect this spatial arrangement and allow for area estimates of this habitat component within each forest type would be valuable for management purposes and model refinement.

Management Implications

The land area identified as suitable for Lewis's Woodpecker in terms of forest type, crown cover, and woody understory greater than 13 percent is mostly managed by the federal government. An estimated 489,350 hectares of these lands are managed by the United States Forest Service. This represents about 71 percent of the total estimated acreage for Lewis's Woodpecker potential breeding habitat in Utah. As such, an opportunity exists for broad-scale management for the benefit of Lewis's Woodpecker and other birds with similar needs. Site occupancy information would go far to refine and/or reinforce the assumptions made in the EIT and this type of analysis.

Sampling efforts for Lewis's Woodpecker using protocols described in Welsh et al (2006) and Zielinski et al (2006) could increase the utility of FIA data in

modeling wildlife habitats as well. All of these methodologies accommodate the use of FIA data as an estimator of existing habitat and as a monitoring tool of the physical environments important to many forest-dwelling species. FIA data can be useful in tracking trends in one or many important attributes, showing predicted future resource availability with and without a given management prescription, a continuing management policy, or as a result of natural disturbances. The nuances of how FIA data are collected and complied need to be fully understood before being applied to a particular question, but the potential for increased data quality and quantity along with substantial reduction in data collection costs should encourage researchers to explore the utility of using FIA data in their wildlife habitat research.

Conclusion

The information gleaned from this analysis is useful in several ways. The land area identified as suitable for Lewis's Woodpecker in terms of forest type, crown cover, and woody understory > 13 percent is mostly managed by the federal government. An estimated 489,350 hectares of these lands are managed by the United States Forest Service. This represents about 71 percent of the total estimated acreage for Lewis's Woodpecker potential breeding habitat in Utah. As such, an opportunity exists for broad-scale management for the benefit of Lewis's Woodpecker and other birds with similar needs. Site occupancy information would go far to refine and/or reinforce the assumptions made in the EIT and this type of analysis.

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