Project #: EMC-2019-001

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Project Title: Assessing vital rates and population connectivity of Black-backed Woodpeckers in green and burned forest within a managed, fire-prone landscape

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Project Duration (Years/Months): The project will run 3 years and 0 months starting June 1, 2020 and will continue until May 31, 2023 (see details in §8 below).

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1. Background and Justification

Woodpeckers (family Picidae) exhibit demographic responses to large-scale disturbance and forest management activities, making them an important group for detecting rapid changes to forest health (Drever and Martin 2010). Because members of this group are considered to be reliable surrogates for the health of the broader bird community (Mikusinski et al. 2001, Drever et al. 2008), they are often used as indicator species to guide forest management decisions. As such, woodpeckers are often central in the debate regarding management activities within fire-prone landscapes of western North America, including post-fire management activities such as salvage logging (Hanson and North 2008, Bond et al. 2012). Among this group, the Black-backed Woodpecker (*Picoides arcticus*, hereafter woodpecker unless otherwise noted) has been at the forefront of this debate because this species has long been considered to require moderate- to high-severity burned conifer forest with standing dead trees (i.e., snags) for supporting breeding populations (Hutto 1995, Saab et al. 2007, Hutto 2008); in contrast, unburned (hereafter green) forest has typically been considered to be low-quality habitat for this species (Hutto 1995, Murphy and Lehnhausen 1998, Hutto 2008). Additional research has found that woodpecker nest survival decreases with time since fire (Nappi and Drapeau 2009), resulting in forest management plans that are aimed at conserving recently burned areas to provide suitable habitat for this species (e.g., Bond et al. 2012).

Although it is clear that woodpeckers use recently burned forest in many parts of its range, two recent studies from the western U.S. have raised questions as to whether this species is restricted to recently burned forest, or instead uses a broader range of forest conditions (California: Fogg et al. 2014; southern Oregon: Verschuyl et al., *in review*). Both of these investigations recorded extensive use of green forests by woodpeckers during the breeding season, even when recently burned areas were available on the landscape. In addition, work conducted in the Cascade Mountains of southern Oregon found especially high occupancy levels in green forest (85% of n=90 transects surveyed), as well as evidence of woodpecker breeding within green forests (n=9 nests; Verschuyl et al., *in review*). Verschuyl et al. (*in review*) used an especially conservative definition of green forest (i.e., no fire activity had occurred within 10 km of survey sites within the past 10 years), indicating that individuals were (1) separated in time and space from recent fire activity, and were not simply occurring on the periphery of burned forest, and (2) sedentary and opted to rear offspring in green forests, and were not transient individuals who were detected while moving through green forest to other locations. Taken together, these recent findings indicate that green mixed-conifer forest is indeed used for breeding by woodpeckers, and that our understanding of the full breath of habitat use in this species remains incomplete. In turn, this has created uncertainty for managers regarding the measures needed to maintain woodpecker populations in light of forest management activities within fire-prone landscapes. This knowledge gap is especially noteworthy given that the woodpecker was previously petitioned for listing on both the California Endangered Species Act (Hanson and Cummings 2010) and the federal Endangered Species Act (Hanson et al. 2012). Although the California Department of Fish and Wildlife (CDFW) did not recommend listing the species (CDFW 2013), nor did the Fish and Game Commission (FGC) list the species (FGC 2013), the U.S. Fish and Wildlife Service determined that the Oregon-Cascades/California population was not genetically distinct given available data and thus was considered ineligible for federal listing (USFWS 2017). Given this decision was based on genetic status alone and no federal status assessment was undertaken, additional legal challenges at the federal level are likely and therefore necessitate information about the full breadth of habitat use by woodpeckers in managed landscapes, including the role green forests play in maintaining populations at the landscape scale, as highlighted by the FGC findings (FGC 2013).

Given the uncertainty about the extent to which woodpeckers use green forests and the potential for green forests to support regional populations (Tremblay et al. 2015), we initiated the first study in western North America to quantify the vital rates that underlie woodpecker population recruitment (i.e., nest survival, post-fledgling juvenile survival) in both green and burned forest of southern Oregon. Our study represents an important step beyond count-based surveys, as estimates derived from such surveys can be misleading as an indicator of habitat quality (van Horne 1983) and preclude determining whether green forests act as source or sink habitats (Pulliam 1988). Against initial expectations, our pilot work has found that woodpecker

vital rates are similar in both green and burned mixed-conifer forest (Rivers and Verschuyl, unpublished data). These results indicate that green forest supports woodpecker populations, and suggests that both habitats may be important for population recruitment at the landscape scale. Nevertheless, two critical knowledge gaps have emerged as a result of these findings. First, our work was conducted largely on the Fremont-Winema National Forest (FWNF), and limited contemporary forest management activities on the FWNF have made it difficult to evaluate how vital rates may are influenced by forest management activities. Therefore, it is imperative to quantify vital rates in areas that are subjected to contemporary forest management activities, including those in landscapes with privately managed forestlands. Second, the extent to which green and burned forest populations are linked at the landscape scale is unknown, including how dispersing individuals make decisions about where to settle for breeding. Breeding dispersal of adults is rare in this species (Tremblay et al. 2016), so the movement of juveniles from their natal areas to their first breeding site (i.e., natal dispersal; Greenwood and Harvey 1982) is expected to be the means by which population connectivity is maintained between green and burned forests. Whether individuals disperse into green or burned forest is likely influenced by several factors that include habitat quality, including the extent and timing of forest management activities (e.g., timber harvest) and natural disturbances (e.g., wildfire) within dispersal ranges. Fortunately, recent advances in animal tracking technology now allow for following individuals during the period of natal dispersal and therefore offer a unique opportunity to understand links between green and burned forests in a manner that has been heretofore impossible.

In this study, we propose to expand our ongoing research to enhance our understanding of how green and burned forests together support woodpecker populations in northern California, and better understand how juvenile dispersal links populations in green and burned forests. Previous work by Fogg et al. (2014) indicate that woodpecker occupancy of green forest occurs across a ~500 km north-south gradient in the Sierra Nevada, so we propose our project in the fire-prone landscape of northeastern California where recent wildfire activity provides an ideal mosaic of managed green and burned forest for comparing vital rates and evaluating connectivity between forest types. As such, this study will greatly expand our nascent understanding of the extent to which green forest support woodpecker populations in the western U.S., the degree to which populations originating in green and burned forest are connected via natal dispersal, and the role of forest management activities and wildfire influence settlement of individuals on the landscape. In turn, this information can be used by private, state, and federal forestland managers interested in maintaining and promoting woodpecker populations, as there is limited and incomplete information available for informing forest management needs for this species within green forests within western North America.

2. Objectives and Scope

In this study, we seek to expand our ongoing efforts to collect vital rate data to better understand the relative contribution of managed green and burned mixed-conifer forests in supporting woodpecker populations, and to determine the extent to which contemporary forest management activities and the California Forest Practice Rules (FPRs) maintain nesting and foraging habitat for woodpeckers. Specifically, our project objectives include: (1) quantifying woodpecker nest survival and habitat components at nest sites within managed green and burned forests; (2) assessing woodpecker juvenile survival, movement, and habitat use in green and burned forests; and (3) characterizing juvenile dispersal movements and settlement patterns that provide connectivity between green and burned forest. By addressing these objectives, our project will provide new information regarding the effectiveness of contemporary FPRs in providing functional wildlife habitat including nest sites and maintaining structures needed for foraging and nesting woodpeckers on managed private, federal, and state forestlands.

3. Critical Questions and Forest Practice Regulations Addressed

Our proposed work is focused on two particular Critical Question Themes of the Effectiveness Monitoring Committee: Theme 7 and Theme 10.

Theme	*Critical Question Theme*	*Natural Resource*	*Forest Practice Rule*	*Priority or Monitoring Questions*
7	Wildlife Habitat: Species and Nest Sites	Habitat and Nest Sites	919.4 [939.4, 959.4]	The effectiveness of Section 919.4[939.4, 959.4] for non-listed species
10	Wildlife Habitat: Structures	Structures	919.1[939.1, 959.1]	The effectiveness of Section 919.1[939.1, 959.1], Snag Retention, "…to provide wildlife habitat…." and to retain a mix of (decay) stages of snag development and restoring snag densities towards "properly functioning" levels.

Regarding Theme 7, our project is centered around woodpecker nesting ecology and thus a fundamental component of our project is to locate and monitor survival of active nests. This includes quantifying vegetation and other habitat measures at nest sites, which will allow for understanding how woodpeckers select these locations, and how selection is influenced by forest type (green vs. burned) and past forest management activities. As stated in the EMC Strategic Plan (EMC 2018), a goal of the FPRs is to maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community with the planning watershed (14 CCR § 897(b)(1)(B)). Objective (1) of our project is designed to meet this goal by determining whether contemporary forest management activities including the current FPRs are effective in maintaining functional wildlife habitat used by woodpeckers on privately managed forestlands in

California. More specifically, Objectives (1) and (2) are also designed to provide results for private forestland owners to determine if any potential impacts may occur to a non-listed species like the woodpecker (14 CCR § 919.4 [939.4, 959.4]). This will allow for testing the effectiveness of current FPRs and associated regulations in protection of woodpecker nest sites.

With respect to Theme 10, woodpeckers typically target standing dead trees (i.e., snags) for the placement of their nest sites, and our project will to characterize nest sites, including the measurement of snags. Objective (1) will provide results for private forestland owners to determine whether contemporary forest management activities including the current FPRs are effective in retaining snags to provide wildlife habitat (14 CCR § 919.1 [939.1, 959.1]) that are part of properly functioning wildlife habitat (14 CCR § 897(b)(1)(B)). In addition, our results should provide information to the critical question: "Are the FRPs and associated regulations effective in retaining, (a) a mix of stages of snag development that maintain properly functioning levels of wildlife habitat?" (EMC 2018). Taken in its entirety, this project will provide results that will serve to evaluate critical questions described in the EMC Strategic Plan Themes 7 and 10.

4. Research Methods

4.1 Study area

Pilot field work undertaken during summers 2018–2019 in federal and state forests of southern Oregon has (1) indicated that a suitable sample of nests can be located in green and burned mixed-conifer forests to provide nest survival estimates and juveniles for VHF telemetry radio-tagging, and (2) confirmed the execution of key field techniques required for our proposed work (i.e., tree climbing, chick extraction from cavities, radio-tag attachment). For this project, we seek to extend our work into northeastern California to work in green and burned portions of private industrial forestland owned by our cooperators (Collins Timber Company, Collins Pine Company, Michigan-California Timber Company, Sierra Pacific Industries; see Letters of Support), as well as on US Forest Service lands that include the Modoc National Forest (see Letters of Support). Selection of study sites will follow that taken in our current work, using a two-step hierarchical approach to identify potential areas in which to work, and then conduct surveys to demarcate which potential sites will be used for the study. To accomplish this, we will first use GIS fire data layers to delineate green forests and burned forest, with burned forest defined as areas that have experienced moderate- to high-severity fire based on RdNBR values (see Galbraith et al. 2019 for approach); this includes large recent wildfires such as the Modoc July Complex that burned >83,000 acres in 2017, and the Stone Fire that burned >39,000 acres in 2018. We will use this information to delineate potential study sites that (1) contain habitat that is known (via previous surveys) or likely to be used for breeding by woodpeckers, (2) are in relatively proximity to each other to accommodate logistics of fieldwork, and (3) and comprise an area large enough (e.g., >3000 acres) to accommodate multiple woodpecker territories to facilitate nest searching and juvenile tracking. Following our current work, we will consider areas to be green forest if they

have been devoid of moderate- or high-severity wildfire within the previous 10 years and are located at least 10 km from sites that have experienced moderate- to high-severity wildfire. We have selected 10 km as a buffer size for green forests because our experience is that larger buffers are unavailable in the fire mosaic landscape of southern Oregon, which represents a similar forest type to that in our proposed study area. Thus, 10 km represents a realistic distance between burned and green sites that can be located on the ground yet still provides areas where multiple woodpecker territories can be located entirely within green forests. In the event that a wildfire occurs within our green forest study sites during the course of our proposed work, it will represent an especially valuable opportunity to study the response of woodpeckers to fire because we will obtain vital rate data representing pre-fire and post-fire conditions at the same location that allows us to evaluate how fire changes woodpecker vital rates and habitat use. In such a case, we would keep monitoring sites and add additional green forest areas if feasible. Given that where and when wildfire occurs cannot be predicted, such a pre-fire/post-fire study design is virtually impossible to implement, but we will capitalize on and make full use of such an unexpected opportunity should it occur.

Once information is obtained on green and burned forests and we have areas to target based on known or expected woodpecker locations, our second step will spend the initial part of the 2020 field season surveying potential study sites to determine which sites are feasible for work. We will do this by searching for woodpeckers using a combination of visual observations and call-playback surveys conducted using a FoxPro NX4 game caller, as call playback is especially useful for increasing detections of breeding woodpeckers and is usually incorporated into survey designs for this species (Saracco et al. 2011, Tremblay et al. 2016). As we identify locations where presence of woodpecker pairs are confirmed, we will transition to nest-searching and monitoring in those particular locations. Our experience in southern Oregon is that occupied forests typically contain multiple breeding pairs in adjoining woodpecker territories, so we expect to build upon initial detections to locate additional nearby breeding sites. As the 2020 season progresses and study sites are accumulated, we will shift from reconnaissance surveys to intensive monitoring of nests on established study sites, and these locations will serve as study areas during the additional two years of field work (2021–2022).

4.2 Nest searching and monitoring

Once a male-female woodpecker pair is located, we will undertake behavioral observations to hone in on potential nest sites by following pairs around their territory. This approach works well for this species because excavation of new nest cavities occurs with each nesting attempt and can take several weeks, both sexes contribute to excavation duties, and the woodpecker is highly tolerant of humans monitoring its behavior, including cavity excavation (Rivers, personal observation). Once a nest cavity is completed, we will undertake regular monitoring of the cavity using a video camera on an extendable pole to scope accessible nest cavities every 3-5 days to

document the timing the first egg is laid (i.e., nest initiation), clutch size, hatching date, proportion of eggs hatching, proportion of chicks surviving, and the date of nest failure or fledging; Figure 1 provides an illustrated overview of this technique.

Our project is focused on understanding how vital rates vary between burned and green forests, which may be linked to local food resources available to breeding adults. To investigate this possibility, we will use digital camcorders to record the provisioning rate of woodpeckers during the nestling stage and quantify potential differences in food provisioned to offspring. To control for variation in food delivery rates that vary through time, we will film nests for at least 90 min when nestlings are at their peak of growth ca. 9–10 days after hatching. This also allows us to have the best view of food items before they are brought into the nest, as older nestlings poke their head out of cavities and quickly take food from adults, making it harder to identify food items. We will place cameras with an 80x optical zoom a minimum of 10 m from nest trees to minimize disturbance to adults and will adjust the camera view such that we will have a profile view of adults before they enter cavities. This allows us to (1) determine which sex is feeding during each event, (2) estimate the load size of the prey item(s) in comparison to the length of the adult bill, and (3) characterize the type of food item(s) being provisioned. After each season is finished, we will hire an OSU undergraduate student to transcribe videos to obtain data on sex-specific provisioning rate, load size, and prey items.

Figure 1 | Illustration of remote video methods used to quantify nest survival and monitor chick development in the Black-backed Woodpecker. Images taken in the nest during each visit to provide an accurate count of the number of eggs and/or chicks in the nest across the nesting cycle. Note images were taken from different nests to illustrate general development pattern.

Immediately prior to the expected hatch date (ca. 22–24 days after hatching), we will visit nests to band and measure chicks. To remove chicks from nest cavities, we will use the hole saw method developed by Ibarzabal and Tremblay (2006). Briefly, we will use a cordless drill with a hole saw attachment to cut a hole approximately 5 cm below the lower edge of the cavity. We will stop the saw prior to cutting into the inner wall of the cavity, and use a chisel and hammer to remove the final wooden “plug” and access the chicks. After we process chicks, they are returned to the nest and the plug is fixed in place with wood screws. We have used this approach

successfully to access woodpecker nestlings on our project without incident, as have others (Ibarzabal and Tremblay 2006, T. Lorenz, personal communication).

Once chicks are in hand, we will band them with a unique combination of a uniquely numbered metal band (USGS Bird Banding Lab) and 1–3 plastic color bands that allow for individual identification when birds are re-sighted in the future. At the same time, we will take several morphological measurements to quantify size-dependent body condition including body mass, tarsus length, bill width, bill length, and wing length. Each chick will then have a small (~70 uL) blood sample taken from the brachial vein on the wing that will be archived for future analysis, as there is limited genetic material from woodpeckers in the southern Oregon/northern California region despite its value in understanding fine-scale genetic structure (Pierson et al. 2010, 2013).

4.3 VHF tag attachment

After blood samples are taken, each of two chicks from an individual nest will be randomly assigned to one of two groups to each receive a lightweight VHF radio-tag. For chicks in the first group, we will attach a small VHF telemetry "beeper" tag (1.8 g, Pip model #Ag393; Lotek Wireless, New Brunswick, Canada) with a ~215 day lifespan. Each beeper tag gives off a constant beeping signal in the VHF range, with each tag assigned to a unique frequency so that multiple birds can be tracked and located at the same time but followed on an individual basis. This will allow us to quantify survival, movement, and habitat use of juvenile woodpeckers throughout the post-fledging period. We will to monitor all tagged birds until late August/early September to obtain data until after individuals gain independence from adults (approximately 30 days after fledging); based on our work with the woodpecker in southern Oregon, we expect to monitor most surviving birds for ≥60 days post-fledgling (Rivers and Verschuyl, unpublished data).

For chicks in the second group, we will attach a small VHF telemetry "connectivity" tag (1.8 g, CTx model #Ag393; Lotek Wireless, New Brunswick, Canada) that functions the same way as the beeper tag except that instead of starting at the time of tagging, the connectivity tag can be programmed (prior to attachment) so that it turns on/off at specific times to conserve battery life and extend tag longevity. We will program connectivity tags to be in a power save mode until turning on in April of the subsequent calendar year after they were attached (e.g., connectivity tags placed on birds in summer 2020 will turn on in April 2021). Once they turn on, connectivity tags will give a constant beeping signal for ≥ 3 months and are detected in the same manner as a beeper tags. We will program tags to start transmitting in April of each year so as to coincide with the timing of the first breeding attempt made by woodpeckers that are tagged as juveniles. Once connectivity tags are active in April of each year, we will work in collaboration with LightHawk Conservation Flying to undertake free aerial telemetry flight(s) over our study area to determine the general location of tagged birds. Once the location of these individuals are established, we will relocate individuals and track them to their nest site using ground-based telemetry. In so

doing, we will gain information about natal dispersal, including the distance dispersed from natal site to the location of first nesting and the forest type (green/burned) in which the tagged individual settled. These nests will be monitored in the same manner as other nests to record nest survival, habitat characteristics around nests, and radio-tag offspring. In turn, this approach allows us to quantify dispersal in families across multiple generations to determine the relative contribution of genetic vs. environmental controls on juvenile dispersal and settlement. Although a subset of birds are expected to undergo mortality before spring, connectivity tags continue to transmit and can be located even if mortality takes place (T. Lorenz, personal communication); thus, we will be able to use data from connectivity-tagged birds to estimate winter survival estimates, which are currently unavailable for this species (Tremblay et al. 2016).

4.4 Relocating individuals with beeper tags and assessing juvenile habitat use

After beeper tags are placed on juvenile birds we will attempt to relocate nestlings at least once every 2 days for the first 10 day post-tagging, and then at least once every 4 days thereafter until mortality occurs or our season ends. This allows us to get as many points as possible so that the timing of death, which is more likely to occur early in the post-fledging period, can be estimated as accurately as possible. We will rotate the timing of tracking so that individuals are tracked at different times of day in each successive day in blocks of 3 days, with one of three period selected randomly (i.e., 7:00-11:00, 11:00-15:00, 15:00-19:00). When re-locating a tagged bird, we will approach it as quietly as possible using a concentric circular search pattern that gets smaller and smaller to pinpoint its location. After a bird has been located, we will follow it for ≥ 30 min at a distance that allows us to record, but not influence, its behavior. During the observation period, we will quantify the time it spends on different behaviors related to foraging (i.e., pecking, gleaning, flaking bark, excavating food, and/or eating), as well as the foraging height above ground and the number of feedings it receives from each parent. Once a bird has moved from a tree, we will mark the tree with a uniquely numbered pin flag, take the GPS coordinates of the tree, and record the pin flag number and coordinates onto a datasheet. Once a particular foraging observation period is finished, we will return to marked trees to record habitat use data. Specifically we will record the tree species, diameter at breast height (DBH), total height, decay class, and other health-related measures (e.g., trunk scorch, needle color, top intact (Y/N), branches present (Y/N)) that may influence use by woodpeckers.

Within 2 weeks of the end of our season, we will conduct LightHawk Conservation aerial telemetry flights to search for birds whose tags have gone missing and cannot be located from ground-based locations. We used this approach in summer 2019 to great effect, finding all but one of the juvenile woodpeckers that had been missing for up to several weeks prior to the flights. In turn, this will allow us to have final determination of final status (dead/alive) for each bird with a beeper tag during the summer breeding and prior to the point later in the fall when

individuals are expected to make long-distance dispersal movements away from natal territories (Tremblay et al. 2016).

4.5 Characterizing habitat at active nest sites and random locations

After each nesting attempt is finished we will conduct nest vegetation surveys to quantify habitat structure around each nest. Understanding nest site selection is particularly important with respect to maintaining populations and testing the adequacy of contemporary FPRs, so we will focus on measuring vegetation at both nest sites and available, but unused, locations to factors influencing nest site selection. First, we will collect data on the nest tree, including tree species, DBH, tree height, cavity height above ground, cavity orientation, cavity diameter, cavity depth, cavity age (new/old), and number of non-use nest cavities. Next, we will collect data on a 10-m radius plot centered on the nest tree (hereafter, nest plot) where we will measure slope, aspect, # of cut stumps, log cover (small, medium, and large logs), live and dead forb cover, and live and dead shrub cover. We will also assess vegetation measures that include basal area of live trees and snags, overhead canopy cover, density of live trees and snags in three diameter classes (10–30 cm, 30–60 cm, >60 cm), and down woody debris (low, moderate, or high).

Once nest plot data are obtained, we will then collect data at two nearby trees that were available but were not used for nesting (hereafter, random plots). To do this, we will select a random azimuth (0-359°) and walk from the nest tree in that direction for 25 m, and then select the nearest conifer tree or snag that is of suitable size for a woodpecker nest tree (i.e., at least 15 cm DBH and a least 1.5 m high). That tree will serve as the random tree #1 (for comparison with the nest tree), with a 10-m plot centered on it (to serve as random plot #1). We will then take the same vegetation measurements as described above on the nest tree and on the nest plot. Once measurements are made on the first random plot, we will return to the nest tree, and go 25 m from the nest tree along an azimuth that is 180° from the first random tree. We will then take the same measurements at random tree #2 and random plot #2 as described above. We will then use data from random trees and random plots to determine which habitat measurements were linked to selection of each nest site within a use vs. availability framework (Johnson 1980, Marzluff et al. 2004, Buskirk and Millspaugh 2006).

4.6 Data analysis and archiving

To analyzed nest survival data we will use logistic exposure models which incorporate exposure time to accounts for nests that are located after the nest is initiated, without making assumptions about when the nest was initiated (Schaffer 2004). This approach has the additional benefits of being able to evaluate the influence of design-based (e.g., forest type) and time-varying covariates (e.g., day of year) on survival (Shaffer 2004, Grant et al. 2005, Shaffer and Thompson 2007). To evaluate post-fledging survival, we will use Cox proportional hazards modeling because this approach does not assume a specific hazard function and it allows for the use of time-varying

covariates (i.e., different measures taken at each time an individual is relocated; Murray 2006). Finally, we will use general linear mixed models to evaluate aspects of dispersal (i.e., distance moved, habitat differences between natal nest site and location of first breeding), nest site selection (i.e., vegetation between nest sites and random sites), and chick provisioning between green and burned forests; all models will be carefully constructing using appropriate independent variables, covariates, and random factors. As part of this process, we will use data shared from cooperating landowners regarding past forest management activities to understand the relationship between management and habitat quality, vital rates, and dispersal movements. In turn, this will allow us to address critical questions in the EMC Strategic Plan Themes 7 and 10 and evaluate the effectiveness of current FPRs as described in § 3 (above).

Our project is poised to collect a large amount of primary data that includes: (1) spatial data regarding the locations of nest sites and individual juveniles woodpeckers as they move about the landscape, (2) chick morphological and genetic data, (3) vegetation-based habitat data from nest sites and locations of where radio-tagged individuals are encountered, and (4) video data from nest provisioning events. Genetic data will be biological samples that will be curated and stored in appropriate long-term housing (-80°C ultracold freezer) within the College of Forestry at Oregon State University (OSU). Hard-copy datasheets will be filed and kept at OSU. Data will be stored on portable hard drives supplied to the field crew and backed up at least weekly during the course of field work on Google Drive. At the end of each season, data will be backed up on the OSU server as well as on an individual hard-drive in the lab of PI Rivers. All datasets will be maintained beyond the life of the project in the digital repository at OSU (ScholarsArchive@OSU) which is a free service that will provide DOIs for each dataset and hold data in perpetuity.

5. Scientific Uncertainty and Geographic Application

At the current time, there is a high degree of uncertainty about the extent to which green forests support breeding populations of woodpeckers in western North America, and whether current FPRs are sufficient to provide habitat for this species in green forests. As noted above, this species has been traditionally viewed as a species requiring moderate- to high-severity wildfire, largely because of earlier studies conducted in forests of the Inland Northwest (Hutto 1995, Saab et al. 2007, Hutto 2008). However, it has only been recently established that woodpeckers occur in green forests of California and Oregon as non-transient, breeding individuals, so information is urgently needed to understand the role green forest play in supporting populations, including quantifying vital rates and connectivity of populations between green and burned forests.

Previous work by Fogg et al. (2014) presented evidence that the woodpecker is found in green forests in California throughout the southern Sierra Nevada (which corresponds with the most southern point in its range) and extends northward for >500 km into the upper reaches of the state. Our ongoing work and that of Verschuyl et al. (*in review*) has demonstrated use of green forest in southern Oregon which, when combined with the findings of Goggans et al.

(1989), extend the known range of woodpecker use of green forest to at least central Oregon. Therefore, this study has relevance for understanding woodpecker habitat use throughout their California range and well into Oregon, which is noteworthy because this is the very population segment that has been petitioned for listing by the federal ESA in the past. Given that the woodpecker occurs in western North American from California into Alaska, this project also has the potential to inform our understanding of fundamental aspects of this species that are largely missing from the scientific record (e.g., juvenile survival, dispersal movements, use of green forest) across its geographic range (Tremblay et al. 2016).

6. Collaborations and Project Feasibility

Our ongoing work examining woodpecker breeding ecology in southern Oregon has been a collaborative research project led by the College of Forestry at Oregon State University and the National Council for Air and Stream Improvement, with support from the US Forest Service, the Oregon Department of Forestry, and LightHawk Conservation Flying. Funding from the EMC would allow us to broaden our collaborative network to landowners in northern California, including Michigan-California Timber Company (lead: Dirk Embree), Sierra-Pacific Industries (lead: Kevin Roberts), Collins Timber Company (lead: Travis Erikson), Collins Pine Company (lead: Bennie Johnson Howell), the USFS Pacific Southwest Region (lead: Sarah Sawyer), and the USFS Modoc National Forest (lead: Pete Johnston). These new collaborators are fully committed to assisting the development and execution of this project (see Letters of Support).

This project is expected to have high feasibility, as our research team has already implemented all of the main project components that are needed to execute this project, including a demonstration of the feasibility of field methods such as nest tree climbing, vegetation measurements, chick extraction from nest trees, tracking of VHF-tagged birds from the ground, and aerial telemetry flights to relocate missing birds. We are continuing to refine our study area in northeastern California, and working closely with our aforementioned research collaborators will allow us to finalize our study sites quickly in spring 2020 and ensure the long-term success of this project. Finally, it is important to note that beeper and connectivity telemetry tags have been used successfully to track fledging woodpeckers immediately after fledgling (Rivers and Verschuyl, unpublished data) and to relocate juveniles at the start of their first breeding season (T. Lorenz, pers. comm.). respectively; thus, the technological methods used on this project have been vetted and work well for collecting the data described within this proposal.

7. Project Deliverables

We will share results from our study broadly with land managers, scientists, and the general public through regular project updates, summaries to funders and stakeholder groups, and through presentations at local, regional, and national scientific conferences. In addition, we will provide at least one field tour during summers 2021 and 2022 to showcase our project to funders,

collaborators, and other interested parties such as forest managers, scientists, policy makers. This project will result in the production of a PhD dissertation, and all data products from this study will be digitally archived and available for future use. We anticipate the production of at least three articles for submission to peer-refereed journals in the field of forest ecology and/or wildlife biology centered around core components of this work: (1) evaluating woodpecker nest survival and critical features of nesting habitat in managed green and burned forests, (2) assessing juvenile woodpecker survival, movement, and habitat use in green and burned forests, and (3) characterizing juvenile dispersal and settlement patterns within a managed, fire-prone landscape. Finally, a technical project report summarizing findings will be submitted to the Effectiveness Monitoring Committee at the conclusion of the study.

8. Detailed Project Timeline

Projected timeline for major activities necessary to meet project objectives. Note that EMC funding covers Years 1-3, with additional project-related activities occurring in Year 4.

	Year 1 (2020-21)				***Year 2 (2021-22)***				***Year 3 (2022-23)***				***Year 4 (2023-24)***			
Activity	***Su***	***Fa***	***Wi***	***Sp***	***Su***	***Fa***	***Wi***	***Sp***	***Su***	***Fa***	***Wi***	***Sp***	***Su***	***Fa***	***Wi***	***Sp***
Establish study sites																
Nest survival & telemetry work																
Matriculation of PhD student																
Updates to funders & collaborators																
Natal dispersal work (tagged cohort from prior year)																
Field tour for funders & collaborators																
Conference presentation(s) of results																
Submit final report to EMC																
Peer-reviewed MS submission																
PhD student defense																

9. Requested Funding

Category	Description*	Year 1	Year 2	Year 3	Total
Personnel	*PI Rivers*	*$9,728*	*$10,020*	*$10,321*	*$30,069*
	PhD Student	*$19,527*	*$26,556*	*$27,088*	*$73,171*
	Undergraduate	*$2,205*	*$2,337*	*$2,477*	*$7,019*
	Subtotal	$31,460	$38,913	$39,886	$110,259
Fringe Benefits	*PI Rivers*	*$5,156*	*$5,511*	*$5,883*	*$16,550*
	PhD student	*$5,077*	*$7,436*	*$8,127*	*$20,640*
	Undergraduate	*$176*	*$187*	*$198*	*$561*
	Subtotal	$10,409	$13,134	$14,208	$37,751
Other	*Services*	*$67,011*	*$51,239*	*$52,778*	*$171,028*
	PhD Tuition & Fees	*$15,456*	*$19,180*	*$20,042*	*$54,678*
	Publications			*$2,500*	*$2,500*
	Subtotal	$82,467	$70,419	$75,320	$228,206
Operating Expenses	Materials & Supplies	$33,269	$15,890	$15,890	$65,049
Indirect Cost	15% of total funds	$32,080	$29,727	$30,954	$92,761
Travel	Domestic	$24,180	$30,100	$30,100	$84,380
Total Cost		$213,865	$198,183	$206,358	$618,406
Matching or In-Kind Contributions ‡					
EMC Funding Requested		**$213,865**	**$198,183**	**$206,358**	**$618,406**

* Detailed Description of Costs

Personnel - Rivers 1.0 month/year in year using a base monthly salary of $9,445 for a total of $30,069. A 3% annual escalation was applied beginning in year 1. PhD Student at 0.49FTE (11 terms) using a base monthly salary of $4,341 for a total of $73,171. The A 2% annual escalation was applied beginning in year 1. Undergraduate students calculated at $12/hour for a total of $7,019. A 6% annual escalation was applied beginning in year 1.

Fringe Benefits - Rivers starts at 53% in year 1 with a 2% annual escalation for a total of $16,550. PhD Student starts at 26% in year 1 with a 2% annual escalation for a total of $20,640. Undergraduate students are 8% with no annual escalation for a total of $561.

Other - (1) Services – Temporary personnel services contract for summer field crew costs are based on weekly rates for leader and 4 techs with annual 3% increase applied. Crew leader is needed in year 1 only as the graduate student will be responsible in years 2 & 3 with costs calculated at $959/week for 18 weeks. Year 1 tech rates are $829.15/week with one tech at 18 weeks and 3 techs at 14 weeks for total of $49,709. Year 2 & 3 costs are escalated at 3%. **(2) Tuition and Fees -** graduate student tuition

is budgeted for 11 terms with AY term costs at $5,152 and SU costs at $2,898 with an annual increase of 4.5% applied per institutional guidance. **(3) Publication Costs/Page Charges -** Costs are based on one publication in peer reviewed journals.

Operating Expenses (Supplies) – Year 1 costs are $33,269 for XL cameras, Garmin eTrex, field tablets, biotrackers and receivers, radio and telemetry tags, antennas, game call and miscellaneous supplies such as PPE gear. Year 2 & 3 costs are $15,890/year and include radio and telemetry tags and miscellaneous supplies such as PPE gear.

Indirect Charges – calculated at 15% on total funding request as specified in RFP

Travel – Domestic

(1) Fieldwork in years 1-3 for *five* fieldwork crew to travel to northern CA/southern OR:

- per diem+ $20/night x 120 nights for 5 people = $12000;
- vehicle $390/month x 12 months$0.3/mi x 25000 miles = $12180;
- per trip total = $12000 plus monthly vehicle costs $12180 = $24180 x 3 years = $72,540

(2) Professional conferences in years 2 & 3 for *two* people (location TBD):

- airfare $800 plus per diem $71/day x 6 days+ $216/night x 5 nights for 2 people = $4,612
- ground transportation $258; registration $650 student $400
- per year total = $5,920 x 2 years = $11,840

‡ Matching or In-Kind – OSU does not allow voluntary match and thus we have not quantified the additional resources being provided. Descriptions of leveraged in-kind costs include tree climbing ladders, instruments to measure vegetation, digital video cameras, and tripods that are being made available from the lab of PI Rivers at OSU. Additional leveraged funds include other related funded grants by NCASI ($80,000), Oregon Department of Forestry ($60,000) and the OSU Fish & Wildlife Habitat in Managed Forests Program ($95,000).

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Letters of support for the proposal: ***Assessing vital rates and population connectivity of Black-backed Woodpeckers in green and burned forest within a managed, fire-prone landscape***

Collins Timber Company LLC
PO Box 1340
Lakeview, OR 97630-0178 USA
541.947.2018
CollinsWood.com

November 05, 2019

Ms. Brandi Goss
California State Board of Forestry and Fire Protection

Re: Dr. James Rivers' Effectiveness Monitoring Project Proposal

Ms. Goss,

I am writing to express support for an Effectiveness Monitoring Project Proposal being submitted to the Calfire by Drs. James Rivers and Jake Verschuyl titled **"Assessing vital rates and population connectivity of Black-backed Woodpeckers in green and burned forest within a managed, fire-prone landscape."** We at Collins Timber Company, LCC are committed to all elements of this study and plans to grant access to the study sites and share data related to past management treatments as it relates to the implementing the study.

Collins Timber Company, LLC recognizes that the California Forest Practice Rules are one of the elements used for enhancing and maintaining functional wildlife habitat, and this is true for the black-backed woodpecker, a species whose use of unburned green forests has limited research data, despite its high relevance to contemporary forest management and policy decisions.

As our foresters and managers have been forced into evaluating forest management under a drier weather regime, treatment and scale has become a topic of significant discussion. The scale, intensity, adjacency and treatment longevity are factors being evaluated as we manage our dry site forests. Species habitat and arrangement will be a critical factor in management decisions Collins will make in the future. By providing a more complete body of research, specific to the black-back woodpecker, landowners and managers will be able to ensure this and another species are maintained for future generations. Research will be used to shape future Forest Practice Rule changes to ensure that forests managed in California address the changes forest management and a public policy.

Therefore, the work proposed by Drs. Rivers and Verschuyl will greatly expand our understanding of the relative contribution of green and burned forests in supporting woodpecker populations, while also determining whether California Forest Practice Rules are currently sufficient for maintaining their nesting and foraging habitat. We think that the team Dr. Rivers has assembled will conduct a superior research project and publish findings that provide valuable insight into an issue that has ramifications for millions of acres of commercial timberland in California and beyond. Therefore, I am writing to indicate we support this proposal.

Sincerely,

Travis Erickson
Lands Manager, Collins Timber Company, LLC

Collins

Collins Pine Company
PO Box 796
Chester, CA 96020-0796 USA
530.258.2111
CollinsWood.com

November 5, 2019

Ms. Brandi Goss
California State Board of Forestry and Fire Protection
1416 9th Street
Sacramento, CA 95814

Dear Ms. Goss,

We are writing in support of the Effectiveness Monitoring Project proposal titled "Assessing vital rates and population connectivity of black-backed woodpeckers in green and burned forest within a managed, fire-prone landscape", being submitted by Dr. James Rivers and Dr. Jake Verschuyl. The Collins Almanor Forest (CAF) is committed to provide support for this research including land access, data sharing, and logistical support. When possible the Collins Almanor Forest will also provide in-kind support for the project.

The California Forest Practice Rules (FPR) are important for maintaining viable plant and wildlife habitat across California, however periodically assessing whether current FPRs still meet these objectives is critical. Black-backed Woodpecker is a species whose use of unburned green forests is poorly understood despite its high relevance to contemporary forest management and policy decisions. Therefore, the work proposed by Dr. Rivers and Dr. Verschuyl is likely to expand our understanding of the relative contribution of green and burned forests in supporting woodpecker populations. This information is important to the CAF in order to help guide management decisions, especially during post-fire events.

We believe that the team Dr. Rivers has assembled is well poised to conduct a competent research project and publish findings that provide relevant to the management of commercial timberland in California. We encourage and support this project proposal and we support a decision to continue funding this work.

Sincerely,

Bennie Johnson Howell, CWB ®
Collins Almanor Forest Wildlife Biologist

MICHIGAN-CALIFORNIA
TIMBER COMPANY

P.O. Box 766
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Phone: (530) 842-2310
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November 8, 2019

Brandi Goss, Environmental Scientist
California State Board of Forestry and Fire Protection
P.O. Box 944246
Sacramento, CA 94244

RE: Letter of Support - Effectiveness Monitoring Project Proposal: *Assessing vital rates and population connectivity of Black-backed woodpeckers in green and burned forests within a managed, fire-prone Landscape.*

Dear Ms. Goss,

On behalf of Michigan-California Timber Company, it is my pleasure to provide this letter of support for an Effectiveness Monitoring Project Proposal being submitted to the California State Board of Forestry and Fire Protection by Dr. James Rivers and Dr. Jake Verschuyl, titled "Assessing vital rates and population connectivity of Black-backed woodpeckers in green and burned forests within a managed, fire-prone Landscape." Michigan-California Timber Company (MCTC) has worked with Oregon State University and the National Council of Air and Stream Improvement on other projects, including studies on the fisher (*Pekania pennanti*) and northern spotted owl (*Strix occidentalis caurina*), and have great respect for their research and areas of focus. I have read the proposal and discussed this project with Dr. Rivers and agree that this is an important project that will not only further our understanding of black-backed woodpecker ecology, juvenile dispersal and habitat relationships, but will help timberland managers balance the needs of timber production and wildlife management. MCTC has agreed to provide access, along with in-kind services, such as maps, information regarding past management activities, and field reconnaissance.

Black-backed woodpeckers (*Picoides arcticus*) are considered a "keystone" species that is generally associated with recently burned forests; however, breeding birds have been found in unburned forests and recent data suggests that nest and juvenile survival is similar to that of burned forests. A petition to list the black-backed woodpecker as either threatened or endangered was submitted to the U.S. Fish and Wildlife Service in 2012. In that petition, the petitioners understated the importance of unburned "green" forests and allege that this species requires a "*.... continuous supply of snag forest habitat comprised of densely packed, recently killed trees in mature and old forest...*" Although it is well known that recently burned forests often support relatively high densities of black-backed woodpeckers, it is more of a boom and bust cycle, with the quality of habitat quickly diminishing during the latter half of the first decade following a fire. This study aims to expand our understanding of the relative contribution of green and burned forests in supporting woodpecker populations, while also contributing to the discussion of whether current Forest Practice Rules are adequate in maintaining sufficient nesting and foraging habitat.

MCTC owns and manages approximately 108,000 acres of timberland in the fire-prone Siskiyou, Trinity and Shasta counties, California. Our management strictly adheres to the California Forest Practice Rules (FPRs), as well as the standards and goals established under the Sustainable Forestry Initiative. It is therefore extremely important that the rules are based on sound, unbiased research and data. We are confident that the team, led by Dr. Rivers and Dr. Verschuyl, will conduct an exceptional research project and publish findings that provide valuable insight into an issue that has ramifications, not only for MCTC, but for millions of acres of private and public timberland. Again, we at MCTC are in full support of this project and request that you extend funding for implementing this work. Thank you.

Sincerely,

Dirk Embree, RPF #2994
Wildlife Biologist

Sierra Pacific Industries

P.O. Box 496014 • Redding, California 96049-6014
Phone (530) 378-8000 • FAX (530) 378-8139

November 5, 2019

Ms. Brandi Goss
California State Board of Forestry and Fire Protection

Dear Ms. Goss,

I am writing to express support for an Effectiveness Monitoring Project Proposal being submitted to the California State Board of Forestry and Fire Protection by Drs. James Rivers and Jake Verschuyl titled **"Assessing vital rates and population connectivity of Black-backed Woodpeckers in green and burned forest within a managed, fire-prone landscape."** We at Sierra Pacific Industries (SPI) are committed to all elements of this study and will permit land access to study sites, share data related to past management treatments, and provide logistical support for implementing the study. We estimate that our in-kind contribution of time would be valued at about $6000.00.

As a private landowner, SPI recognizes that the California Forest Practice Rules are important for enhancing and maintaining functional wildlife habitat, and this is especially true for the Black-backed Woodpecker, a species whose use of managed and unburned green forests is poorly understood despite its high relevance to contemporary forest management and policy decisions. Therefore, the work proposed by Drs. Rivers and Verschuyl will expand our understanding of the relative contribution of green and burned forests in supporting woodpecker populations, while also determining whether California Forest Practice Rules are currently sufficient for maintaining their nesting and foraging habitat. We think that the team Dr. Rivers has assembled will conduct a quality research project and publish findings that provide valuable insight into an issue that has ramifications for millions of acres of commercial timberland in California and beyond. Therefore, I am writing to indicate we support this proposal, and request that you extend funding for implementing this work.

Sincerely,

X

Kevin Roberts
Wildlife Program Manager

USDA United States Department of Agriculture | Forest Service | Pacific Southwest Region

Regional Office, R5
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Vallejo, CA 94592
(707) 562-8737 Voice
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Date: 11/04/2019

Ms. Brandi Goss
California State Board of Forestry and Fire Protection

Dear Ms. Goss,

I am writing to express Region 5 of the US Forest Service's support for the Effectiveness Monitoring Project Proposal being submitted to the California State Board of Forestry and Fire Protection by Drs. James Rivers and Jake Verschuyl titled "Assessing vital rates and population connectivity of Black-backed Woodpeckers in green and burned forest within a managed, fire-prone landscape."

As a land management agency, the USFS is mandated to manage for a suite of conservation objectives and ecosystem services, including providing habitat for California's native wildlife in the face of unprecedented ecological change. We collaborate extensively with private landowners and the State of California to accomplish these objectives, and require a sound scientific basis on which to found our decision-making process. Collaboration across forest ownerships in California, and increased scientific knowledge of wildlife habitat use in California Forests, are both critical to meet many of our objectives, but especially our shared goals to reduce the risk of severe fire on the landscape and to increase connectivity for species, a key component of our 2012 Planning Rule.

The proposed study focuses on evaluating the relative contribution of green (unburned) and burned forests to supporting populations of the Black-backed Woodpecker, a species that has been at the center of debate and litigation around forest management practices and policy decisions in California in recent years. This project will provide the type of information needed by forest landowners to understand the implications of their practices on a broad scale and modify practices to better meet their many objectives. Further, it will provide the relevant information for us to look beyond burn scars, and manage at the landscape scale to increase future resilience to disturbance and habitat connectivity. The research team led by Drs. Rivers and Verschuyl is well-suited to implement, conduct, and share results from their important work with scientists, managers, and policy makers.

The USFS Region 5 is committed to fully engaging with this study, should it be funded, and plans to permit land access to study sites, share data related to past management treatments, provide logistical support for implementing the study, and ensure that the science-management partnership this work will facilitate is fruitful and applied. Therefore, I am writing to indicate our strongest support for this proposal, and hope that you find this project is suitable for funding.

Sincerely,

Sarah Sawyer
Regional Wildlife Ecologist

United States Department of Agriculture
Forest Service
Modoc National Forest
225 West 8th Street
Alturas, CA 96101
530-233-5811
TDD: 530-233-8708

File Code: 2600
Date: October 24, 2019

Ms. Brandi Goss
California State Board of Forestry and Fire Protection

Dear Ms. Goss,

I am writing to express support for an Effectiveness Monitoring Project Proposal being submitted to the California State Board of Forestry and Fire Protection by Drs. James Rivers and Jake Verschuyl titled **"Assessing vital rates and population connectivity of Black-backed Woodpeckers in green and burned forest within a managed, fire-prone landscape."** We at the US Forest Service are committed to all elements of this study and plans to permit land access to study sites, share data related to past management treatments, and provide logistical support for implementing the study.

The black-backed woodpecker has been identified as one of 12 "management indicator species" for the National Forests in Region 5. As such, information relating to relative abundance and population dynamics is important for evaluating potential impacts of projects on various habitat types. The black-backed woodpecker represents medium and large snags in burned forest. This species has been targeted by conservation groups concerned about this species. Consequently, research which helps better understand this species would help biologists such as myself provide better environmental analysis and potential impacts to black-backed woodpecker and similar species.

Like nearly all of forest landowners, the US Forest Service has multiple goals for forest management, including providing habitat for all of California's native wildlife. Balancing these goals is difficult, and information to inform the practices that support each of these goals is critically necessary. This study focuses on evaluating the relative contribution of green (unburned) and burned forests to supporting populations of the black-backed woodpecker, a species that has been at the center of discussions around forest management practices and policy decisions in recent years. Thus, this project will provide the very type of information needed by forestland owners to understand the implications of their practices on a broad scale and modify practices to better meet their many objectives. The research team led by Drs. Rivers and Verschuyl is well-suited to implement, conduct, and share results from their important work with scientists, managers, and policy makers. Therefore, I am writing to indicate my strongest support for this proposal and hope that you find this project is suitable for funding.

Sincerely,

/s/ Peter Johnston
West Zone Biologist
Modoc National Forest