Brief summary from the Kings River Fisher Project in regards to

tree mortality, fishers, and fisher habitat in the southern Sierra Nevada

Submitted to the United States Fish and Wildlife Service

Submitted by Rebecca Green[1], Kathryn Purcell[1], and Eric McGregor[2]

[1]*Pacific Southwest Research Station, USDA Forest Service*

[2]*Institute for Natural Resources, Oregon State University*

5 April 2019

Background

The Kings River Fisher Project (KRFP) is a long-term study of fisher ecology in the southern Sierra Nevada conducted by the Pacific Southwest Research Station of the USDA Forest Service. This project was initiated in 2007 by Kathryn Purcell and Craig Thompson. Rebecca Green joined the field crew in summer of 2007, and completed a dissertation on fisher reproductive ecology in 2017 using data from KRFP (Green 2017). Although the study was originally intended to run for 7 years, the project was extended and field work is now expected to end in February 2020 with an additional year for analysis and writing. We have given numerous presentations and have been associated with a number of collaborative papers highlighting the unique characteristics of reproductive ecology, use of habitat, and risk factors for this isolated population of fishers in the southernmost portion of the distribution in North America that are available for reference in the current process to assess the status of fishers in western states (e.g., Gabriel et al. 2015, Green et al. 2018, Wengert et al. 2014). Additionally, we can add to the available resources a recent peer-reviewed paper that emphasizes the value of large diameter trees with cavities and other unique microsites to support daily resting and seasonal reproductive activities (Green et al. 2019). In this study we found that California black oaks (*Quercus kelloggii*) were a significant resource for female fishers as reproductive dens, but conifer species were also an important source of reproductive den structures (especially at higher elevations) and were widely used as resting structures across elevations. However, our most recent research is still on-going and not yet in a report or peer reviewed manuscript; hence, we have opted to provide a brief update.

Between 2012 and 2014, a severe drought impacted much of California, including the Kings River study area in the southern Sierra Nevada. This period was followed by extensive tree mortality (2015 to present) due in large part to trees (particularly conifers) stressed from lack of water and widespread outbreaks of bark beetles. The tree species most affected by this combination of drought and beetles in areas occupied by fishers in the Kings River study area are conifers, including pines and firs. Although there were some changes in methodology on the project beginning in the fall of 2017 (e.g., switching from VHF to GPS collars to monitor fishers), field work on KRFP has been conducted continuously from 2007 to present. This continuity in data collection has provided an opportunity to evaluate fisher habitat use pre-tree mortality, during the drought, and throughout the tree mortality event. This dramatic change to the landscape has occurred relatively recently, forests in this region continue to

undergo changes, and we are still gathering and analyzing data to better understand the associated response of fishers and fisher habitat. As a result, we have not yet completed analyses and manuscripts on these topics yet, however analysis is in process and we anticipate that some of these results will be available later in 2019 and continuing over the next few years as a number of collaborative projects are completed.

The primary purpose of this document is to highlight aspects of our current research that are not yet available in a completed format (e.g., final report, peer reviewed manuscript), but which may be of value to the USFWS in considering the extent of tree mortality within fisher habitat in the southern Sierra Nevada and the potential for impacts on fishers in this geographic area. Because we were hesitant to present data that are still being collected and analyses that are not yet finished, we focused on examples of the magnitude of the tree mortality phenomenon in areas known to be occupied by fishers prior to tree mortality in the Kings River study area and an example from our current study of fisher use of a landscape dominated by tree mortality. While we cannot yet provide a complete analysis on the full extent of changes to fisher habitat and response of fishers in this region, we can emphasize that the recent tree mortality is an unprecedented landscape-level change likely to affect habitat characteristics important to fishers such as: extent of canopy cover, availability of large conifers for resting and denning, and availability of conifer seed cones of value to some prey species (e.g., squirrels). In addition, concerns for human safety, fire risk, and landscape restoration have led and will continue to lead to removal of dead trees which result in additional changes to the landscape. We are only beginning to understand the potential impact of these cumulative changes on fishers in the southern Sierra Nevada.

The KRFP study area is located in the Sierra National Forest near the town of Shaver Lake, California (see Green et al. 2019 for further description). The main elevation zone used by fishers in our study area falls between about 3,000 – 7,000 ft (914 – 2134 m), with some individuals moving above and below this range. Tree mortality has occurred across the Kings River study area and impacts vary by elevation and tree species. The three species most negatively impacted are ponderosa pine (*Pinus ponderosa*; generally at low to middle elevations), sugar pine (*Pinus lambertiana*; largely at middle to high elevations), and white fir (*Abies concolor*; present at middle elevations but widespread at high elevations). California black oak and incense cedar (*Calocedrus decurrens*) are the other dominant species within our study area, but they were not impacted by beetles and tend to be more drought tolerant so have fared better than local pine and fir species.

To facilitate analysis of fisher response to tree mortality and changes within the landscape, Eric McGregor generated annual maps of tree mortality beginning in the first year of quantifiable tree mortality (2015). We mapped tree mortality and other land cover types for 2015, 2016, and 2017 at a 5 meter pixel resolution using RapidEye satellite imagery captured in August for each year. We conducted a supervised classification using a random forest classifier to map five land cover categories: bare ground, live forest, tree mortality, shrub, and meadow. These data layers are used in the maps we have included here to provide examples of the extent of the tree mortality at several spatial scales: study area, home range, and movement path.

Study area spatial scale (Figure 1). To provide an indication of how the tree mortality phenomenon has affected areas of high value to fishers in the KRFP study area, we combined the annual home ranges (95% kernel) of female fishers that denned in the years prior to extensive tree mortality (2008 – 2015) to

represent habitat that can support fisher reproduction in this region at a landscape scale (see Figure 1). The total area used by reproductive females in this core portion of the study area was 27,977 ha. Within this area, the number of hectares affected by tree mortality started at 2,078 in 2015, increased to 7,490 in 2016, followed by a total of 8,053 in 2017. Considering only the forested portions of this key part of our study area, the percent of forest impacted by tree mortality was 12.8% in 2015, 43.6% in 2016, and 50.8% in 2017. So, while we are still assessing the impacts of tree mortality on fisher habitat and the local population, we can confirm that tree mortality is prevalent in areas of key importance to fishers within our study area.

Home range spatial scale (Figure 2). At the home range scale, we selected an example home range of a reproductive female fisher (F16) from 2014 to demonstrate how the habitat available for female fishers has changed as a result of tree mortality in subsequent years, as well as how management activities to cope with tree mortality have begun to alter the landscape (Figure 2). F16 occupied a lower elevation zone of our study area that was dominated by a mix of California black oak and ponderosa pine and other tree species (including canyon live oak (*Quercus chrysolepis*), incense cedar, sugar pine, and white fir) as well as shrubs and areas of open granite. She reproduced in this general area nearly every year between 2009 -2015. Beginning in 2015, a large proportion of the ponderosa pines (and some other conifers) in this area died, but many live California black oaks and canyon live oaks remain. F16's estimated home range (95% kernel) for 2014 was 2,315 ha. The total number of hectares impacted by tree mortality within this area was 268 in 2015, 526 in 2016, and 399 in 2017. In this particular example, the lower number of hectares impacted by tree mortality in 2017 reflects the removal of conifer snags in some areas (particularly along roads, see map of 2017) but may also include snags beginning to fall on their own. The proportion of forested habitat impacted by tree mortality in F16's 2014 home range was 26.3% in 2015, 52.6% in 2016, and 52.7% in 2017.

Movement path spatial scale (Figure 3). In 2018 we transitioned to GPS collars to provide more detailed location data to examine response to tree mortality. Analysis of movement path data from GPS collars on fishers will help us better understand how fishers are using this altered landscape. These analyses should help elucidate the role of tree mortality in fisher habitat selection and movement behavior. Additionally, they may help us better understand how fishers are moving around areas that have been treated, potentially providing future guidance for configuration of fuel breaks and/or restoration activities. Figure 3 illustrates how one male fisher navigated a landscape where conifer mortality (predominantly ponderosa pine) was a major component in a matrix containing live conifers in riparian drainages and shrub and oak species on exposed slopes. These data were collected at two different temporal resolutions (5 and 15 minute intervals), and together represent movement paths over a continuous 16 day period from 1 November to 16 November 2018.

Concluding thoughts and on-going efforts. In conclusion, we first want to acknowledge that our field study and efforts to quantify the impacts of tree mortality on fisher habitat and any associated fisher response are still on-going. Hence we are hesitant to present findings that are too preliminary. And although our study was not originally designed to investigate tree mortality, we are now in a unique situation with pre-tree mortality data on fishers in the southern Sierra Nevada to assess how areas used by fishers have changed and evaluate fisher use with this altered landscape. Despite the preliminary nature of some of our findings, we thought it was important to convey the extent of the recent tree mortality within forested areas of importance to a local fisher population (e.g., areas that support reproduction) within a portion of the range that is already experiencing other risk factors (e.g., isolation,

low genetic diversity, exposure to rodenticides, overlap with areas of high fire risk) and let USFWS personnel know that findings from this study should become available over the next year.

Based on observed patterns of tree mortality in this landscape combined with prior knowledge of fisher ecology and habitat use, we expect large patches of intact live forest to be essential to fishers in the southern Sierra Nevada. We expect that these areas will maintain characteristics of high value to fishers including higher levels of canopy cover, thermal refugia in hot conditions, and important areas for prey species. We also expect forest patches associated with riparian areas, which appear to be less impacted by tree mortality, to be of particular importance for fishers in this altered landscape. We hope to have results and completed analysis available on this topic in the relatively near future.

We expect data on movement paths will be helpful in identify travel corridors for management recommendations. Preliminary results suggest that fishers are more likely to be found close to streams and in drainages and ravines. While fishers may not use different areas than those used previously, we expect they may be more constrained to drainages. These areas may be especially important for connectivity within home ranges and between larger patches of live forest. As we continue to collect data, another key question is how fishers will respond when snags fall and become logs. Conifer snags are used for both resting and denning by fishers and are key habitat elements, but as snags fall den sites in particular will likely become more limiting. Snags contribute to canopy cover and help provide thermal benefits to this species at the southern extent of its range. As snags fall and the forest becomes more open and hardwood dominated, it will likely be transformed into a forest type not previously seen on the landscape. Fisher response to this new habitat type is unknown.

References

Gabriel, M.W., Woods, L.W., Wengart, G.M., Stephenson, N., Higley, J.M., Thompson, C., Matthews, S.M., Sweitzer, R.A., Purcell, K.L., Barrett, R.H., Keller, S.M., Gaffney, P., Jones, M., Poppenga, R., Foley, J.E., Brown, R.N., Clifford, D.L., Sacks, B.N., 2015. Patterns of natural and human-caused mortality factors of a rare forest carnivore, the fisher (*Pekania pennanti*) in California. PLoS ONE 10, e0140640.

Green, R.E., 2017. Reproductive ecology of the fisher (*Pekania pennanti*) in the Southern Sierra Nevada: an assessment of reproductive parameters and forest habitat used by denning females. Dissertation. University of California, Davis, California.

Green, R. E., K. L. Purcell, C. M. Thompson, D. A. Kelt, and H. U. Wittmer. 2018. Reproductive parameters of the fisher (*Pekania pennanti*) in the southern Sierra Nevada, California. Journal of Mammalogy 99:537-553.

Green, R. E., K. L. Purcell, C. M. Thompson, D. A. Kelt, and H. U. Wittmer. 2019. Microsites and structures used by fishers (*Pekania pennanti*) in the southern Sierra Nevada: A comparison of forest elements used for daily resting relative to reproduction. Forest Ecology and Management 440:131-146.

Wengert, G.M., Gabriel, M.W., Matthews, S.M., Higley, J.M., Sweitzer, R.A., Thompson, C.M., Purcell, K.L., Barrett, R.H., Woods, L.W., Green, R.E., Keller, S.M., Gaffney, P.M., Jones, M., Sacks, B.N., 2014. Using DNA to describe and quantify interspecific killing of fishers in California. Journal of Wildlife Management 78, 603‐611.

Figure 1. At the landscape scale, this time series shows the progression of tree mortality across the portion of the Kings River study area used by reproductive female fishers (combined home ranges for years 2008-2015). Measurable tree mortality first occurred in 2015, with a notable increase by 2016. Note that our tree mortality data currently only covers elevations of key relevance to fishers (3,000 – 7,000 ft).

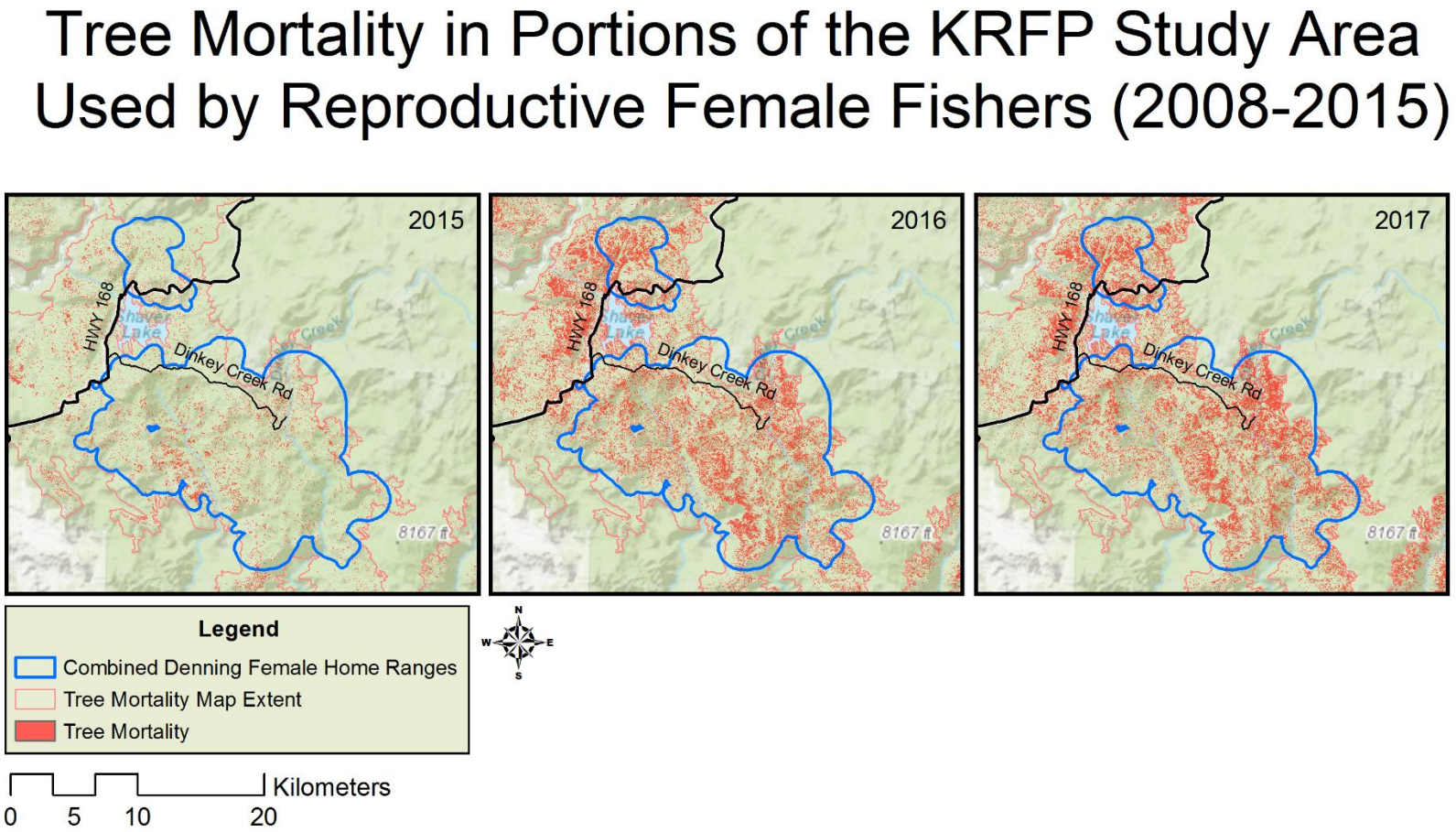

Figure 2. An example of an adult female fisher (F16) home range from 2014 located within a lower elevation area of the Kings River study area. This female reproduced nearly every year in this general area from 2009 – 2015. Year 2014 (shown with NAIP 1m imagery) represents the time period at the end of the drought, but before extensive tree mortality. In 2015, ponderosa pines in this area began to die and in 2016 the mortality was extensive. In 2017, management activities to remove dead trees begin to change tree mortality areas to bare areas on the map (note arrows).

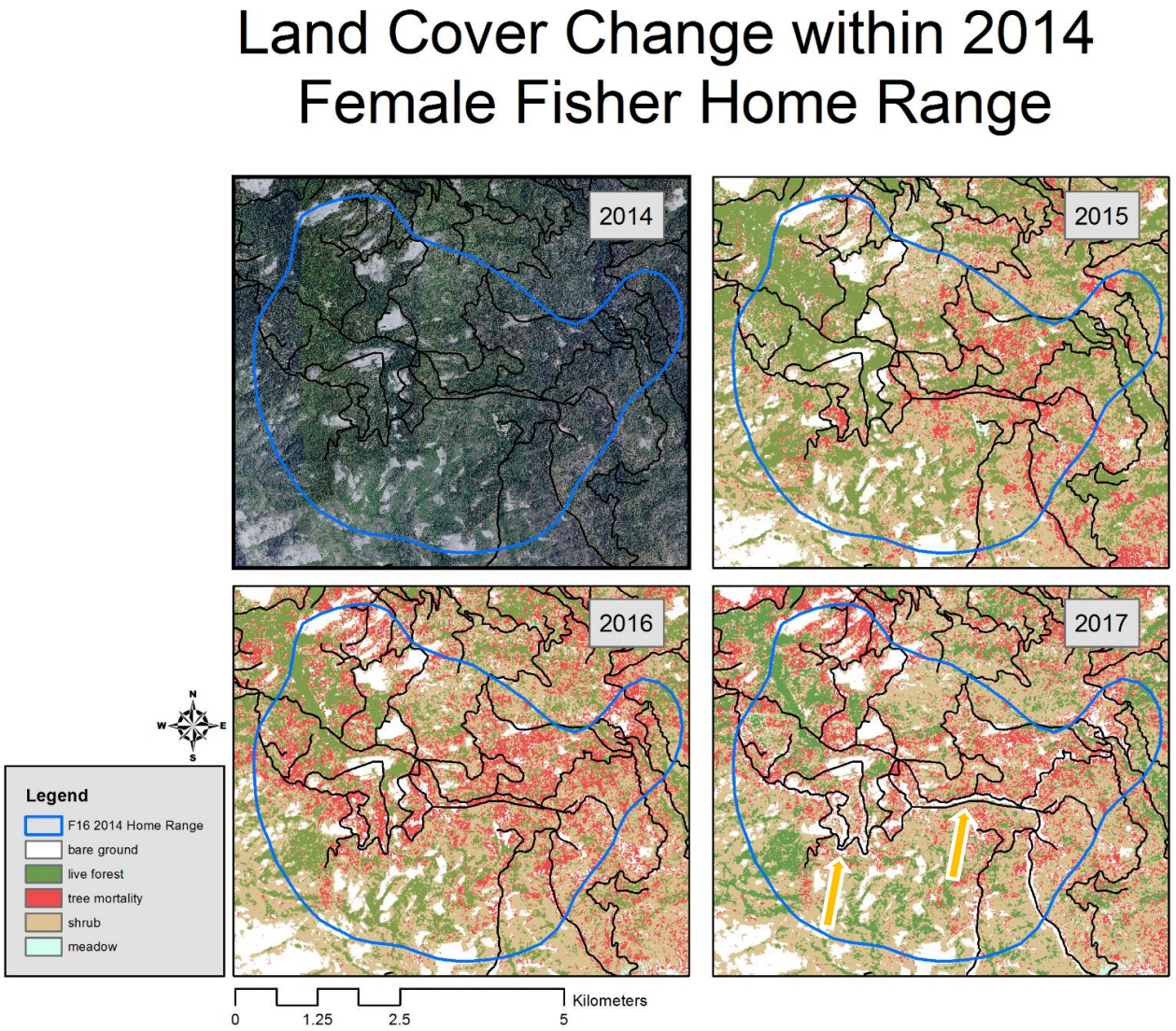

Figure 3. An example of a movement path taken by a male fisher in the Kings River study area over a 2 week period in November 2018. This fisher used middle to low elevations of the Kings River study area and locations are plotted on our tree mortality map. GPS fixes were attempted by the collar at 15 minute intervals from 1 November – 9 November, then switched to 5 minute intervals from 10 November to 16 November.