UNDERSTANDING A FISHER REINTRODUCTION IN NORTHERN CALIFORNIA FROM 2 PERSPECTIVES

(Former annual reports entitled: Reintroduction of Fishers into the Northern Sierra Nevada of California)

Annual Report for 2013

For the period of October 2009 to December 2013

By

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SUMMARY

From late 2009 through late 2011, we released fishers (*Pekania pennanti*) (24F, 16M) onto the Stirling Management Area owned by Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains. We monitored all fishers as often as possible for survival, reproduction, dispersal, and home range development through 2013 (year-4). The released fishers experienced high survival during both the initial post-release period (4 months) and for up to 2 years after release. We found 16 fishers dead, 5 in 2013. We have documented reproduction in all years of the study and from all translocated cohorts. Of the 40 fishers in the 3 release cohorts, we tracked 32 (80%) long enough to document the establishment of home ranges. Males had larger home ranges and travelled further than females. Fishers from some source populations were infected with eye worms (*Thelazia californiensis*) and some fishers from Humboldt and western Trinity counties were infected with a previously undescribed trematode. In October of 2013, we conducted a large scale, annual trapping effort on Stirling to recapture previously released fishers and their progeny. During this trapping effort we captured 7 juvenile fishers (6F, 1M) and recaptured and re-collared 15 adults (11F, 4M). On average, released female fishers upon recapture had increased their weights by 0.1 kg and males by 0.4 kg. Juvenile fishers captured on the Stirling Management Area weighed more than similarly aged juveniles from other parts of California.

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INTRODUCTION

The human-assisted movement of animals goes back thousands of years in Europe (Alcover, 1980; Masseti, 1995) and more than a century in North America (reviewed by Bolen and Robinson, 2003) but, until recently, feasibility planning and research design have not been incorporated into translocations (Biggins et al., 2011; Breitenmoser et al., 2001; International Union for the Conservation of Nature, 1995; Lewis et al., 2012; Miller et al., 1990a, 1990b; Powell et al., 2012). Unfortunately, reintroductions of endangered species in recent decades have experienced frequent failures (Armstrong and Seddon 2008). Efforts to counteract failures have led to better planning and to introducing experimental design into reintroductions (e.g., Miller et al. 1990a,b; Lewis and Hayes 2004; Callas and Figura 2008; Biggins et al.2011). In addition, a critical factor that has received little attention is the effect on a source population of removing prime, reproductive, adult animals, animals with high reproductive value (v_x), to be released elsewhere (Armstrong and Seddon, 2008; Powell et al., 2012). The effects on a source population of removing prime, reproductive animals are potentially greater than those of trapping similar numbers of animals for fur (Buskirk et al., 2012), which can include large numbers of non-reproductive juveniles.

Because of concern for the status of fishers in California, to understand better why some fisher reintroductions have succeeded while others have failed, and to understand how fishers in particular, and mammalian predators in general, respond to intensive forest management, the California Department of Fish & Wildlife (DFW), the US Fish & Wildlife Service (FWS), Sierra Pacific Industries (SPI) and North Carolina State University (NCSU) are collaborating to re-establish a fisher population in the northern Sierra Nevada of California. In 2009, the California Department of Fish & Game gave final approval for 40 fishers to be reintroduced over the following 3 years (2009-2012) onto SPI's 648 km^2 Stirling Management Area (hereafter "Stirling"), which is managed intensively for timber production. The released fishers and their progeny are to be studied intensively for the first 7 years post-reintroduction.

In an effort to understand the fisher population in the far northeastern extent of the fisher's range in California, we began in 2006 to use non-invasive methods to estimate population parameters for the fishers living on the managed, forested landscape centered on the Klamath River in Northern California and Southern Oregon (Figure 1.) Combining the non-invasive, genetic surveys conducted in this study area with the research on reintroduced fishers on Stirling provided the opportunity to broaden conservation benefits for fishers (e.g., Seddon et al. 2007, Sarrazin and Barbault 1996), to understand better the dynamics of fisher populations on managed landscapes, and to study a source population for a reintroduction. Fishers were removed from the study area in the winters of 2009-2010 and 2010-2011. These removals were targeted to lands owned by Michigan California Timber Company, meaning that fishers were removed from managed, industrial timberlands and released on a different but also managed landscape. The removed animals were targeted to be adult members of the population with high reproductive potential.

The primary objectives of this research are to:

1. Study the fishers in the new population on Stirling to document their survival, reproduction and use of habitat.

2. Evaluate the use of habitats by reintroduced fishers and their offspring to test the predictions of models of habitat quality and suitability for fishers, including but not limited to the models of Allen (1983), Carroll (2005), Davis et al. (2007), California DF&G (2002), a model developed by Sierra Pacific Industries for its Candidate Conservation Agreement with Assurance with the FWS, and a model developed by the research team at North Carolina State University.

3. Obtain baseline genetic (DNA) data on reintroduced fishers and their offspring.

4. Collect data on the use of structures for natal dens, maternal dens, and for resting by reintroduced fishers and their offspring.

5. Sample reintroduced fishers and their offspring for general and exposure to diseases.

6. Using models of optimal home range choice, predict the placement, sizes, and shapes of home ranges of reintroduced fishers and their offspring, and test the predictions using data on actual use of space by those fishers.

7. Predict patterns of breeding by Stirling males from home range placement and familiarity with landscapes and test those predictions using data on paternity of fishers born in the study area.

8. Combine data from Objectives 1-5 to evaluate potential causes of failure if fishers do not become established in or near the release area, or to evaluate primary reasons for success if they become established. This objective will allow us to determine whether the conservation measures outlined in the CCAA are sufficient to sustain fisher populations on managed landscapes.

9) Estimate abundance, survival and recruitment, population growth rate and occupancy for the source population of fishers in the Eastern Klamath region through 2016.

10) Estimate the effects on abundance and population growth rate, if any, caused by removing fishers in 2009-2010 for release on Stirling.

11) Evaluate the original non-invasive study design, redesign the monitoring protocol as necessary, and test the redesigned protocol for use as a monitoring tool for the reintroduced fisher population on Stirling.

Here we report on research activities that address these goals directly for year-4 (January– December 2013) of the project. We review non-invasive research in the Klamath Region and the reintroduction activities to date. We have written this report to fulfill our obligation specified in the Memorandum of Understanding among the California Department of Fish & Game, the US Fish & Wildlife Service, Sierra Pacific Industries, and North Carolina State University; and to present the results of research conducted with funding from the California Department of Fish & Wildlife and the US Fish & Wildlife Service.

REINTRODUCTIONS OF FISHERS

We achieved the goal of reintroducing 40 fishers (24F, 16M) from late autumn 2009 through late autumn and early winter 2011 (Callas and Figura 2008, Powell et al. 2012), which we completed in December 2011 (Powell et al. 2012). In years-1, -2 and -3 we moved 15 (9F, 6M), 13 (7F, 6M), and 12 (8F, 4M) fishers to Stirling, for the total of 40 fishers (Powell et al. 2012). We released fishers across much of Stirling (Figure 2; Powell et al. 2012). Since the final releases were completed at the end of 2011 and reported in the Annual Report for 2011, year-2, we include no further details about the releases here. Rather, we here on emphasize efforts to locate fishers and to document reproduction, survival, space-use and other factors related to the released fishers and their progeny living on Stirling during 2013 (year-4). Year-4 was the first year during which all fishers born on Stirling had been conceived on Stirling after the last release of fishers.

GENERAL CONDITION, DISEASE, AND ECTOPARASITES

We assessed the health of all fishers that we captured on Stirling by conducting detailed physical examinations at the time of capture. We collected blood, mucosa and fecal samples to determine disease exposure to pathogens that could affect population health through either direct mortality of adults or kits, or impaired reproduction. Samples were sent to the Integral Ecology Research Center, McKinleyville, California, where they will be tested for canine distemper virus, canine parvovirus and *Toxoplasma gondii* (toxoplasmosis) at a later date. Fishers captured on Stirling still appeared to be in good general condition. We have seen no physical abnormalities in either adult or young fishers born on Stirling that would cause concern. During physical examinations, at least 2 biologists (usually a field biologist and a wildlife veterinarian) graded fishers for general condition based on the condition of their teeth, skin and fur, musculature, obvious wounds or injuries, ectoparasite load, weight, and amounts of fat over the hips and ribs. We defined poor condition as having obvious, serious injuries, very low levels of body fat, and high ectoparasite load. We defined excellent condition as having no signs of serious injury, having all carnassial and canine teeth with

little wear on their incisors and premolars, and having high levels of fat over hips and ribs. We defined average condition as being not obviously in poor or excellent condition. Fishers in average condition may have minor injuries and may have missing or highly worn teeth, but have no conditions that cause concern.

Of 52 captures of fishers on Stirling through December 2013 (recaptures of reintroduced fishers and captures of fishers born-on-site), none were graded in poor condition, 35 (67%) were average and 17 (33%) were excellent. No obvious differences in overall condition existed between males (69% average condition) and females (65% average condition). These percentages are similar to (though modestly better than) our assessments of fishers that we considered for reintroduction (some are the same fishers). Of 86 fishers that we evaluated for potential reintroduction during 2009-2011, 2% were in poor condition, 73% average and 24% excellent. We have not tested whether these evaluations of condition vary among sites and currently have no objective measure outside of age-specific body weights to compare to our subjective scores.

Through year-4 of our research, we have collected ectoparasites of 4 taxa from fishers. Fleas and ticks were relatively common and were collected from 40% to 50% of the fishers examined (Figure 3). Fleas and ticks have yet to be identified by taxonomic groups. We have also collected eye worms (*Thelazia californiensis*) from the eyes of fishers at source locations and on Stirling. Though documented on other wildlife and domestic animal species and relatively common in California in the past (Burnette et al. 1956, Voge 1956), eye worms were not reported to parasitize fishers prior to this project. We have reported the occurrence of a new trematode species living in the perianal tissue of fishers and apparently restricted in geographic range to coastal areas of California (Clifford et al. 2012). The description of this new species trematode is in preparation (Tkach and Clifford, unpublished data). Fleas, ticks and eye worms occur on fishers at Stirling at slightly lower prevalence compared to fishers captured at our source locations. We released no fishers on Stirling known to have been infected with the new trematode and to date we have not detected the trematode on fishers living on Stirling. Consequently, we are optimistic that we did not introduce the parasite to the reintroduction site accidentally. We shall continue to examine all fishers captured on Stirling for infection. The role that ectoparasites play in the establishment or viability of fisher populations on Stirling is unknown, but the similar levels of occurrence of fleas, ticks and eye worms in the translocated and source populations suggests that similar levels of ectoparasitism exist at all sites.

LOCATIONS, MOVEMENTS AND HOME RANGES

In year-1, we implanted female fishers with IMP-310 very high frequency (VHF) transmitters made by Telonics (Mesa, Arizona) and 4 (of 9, 44%) failed prematurely (< 8 months). In year-2, we used Telonics MOD-125 collars for females. None failed prematurely. In year-3 we outfitted females with MI-2i collars made by Holohil Systems Ltd (Carp, Ontario CA) because they weighed less than the Telonics MOD-125 collars and their external design was less bulky. Two of the 14 (14%) Holohil transmitters failed prior to their estimated battery expectancy of 24-30 months. In year-4, outfitted females (12) only with Telonics MOD-125 collars. In years-2, -3 and -4 we outfitted young fishers born on Stirling with radio collars only if the fishers had necks that were unlikely to grow substantially (>2 cm) in the future. Young fishers that might gain substantial body weight or increase their neck sizes were either implanted with a radio-transmitter or were not given a transmitter.

We radio-tracked 22 females during the calendar year 2013, some for only a few weeks after being trapped in November, others all year, and averaging about 7½ months. The females wearing transmitter collars maintained home ranges spread widely across Stirling and onto adjacent land. Consequently, we targeted females who lived centrally to locate daily and attempted to locate peripheral females weekly. Given the weather, the mountainous terrain, limited personnel, and myriad other conditions that affect VHF telemetry, we rarely achieve this goal. For all females, we averaged 1.9 $\pm$ 1.1 (±SD; Table 1) estimated locations per female per week but 2.2 estimated locations per week for target females. For each estimated location, however, we had almost as many attempted locations that

ended up meeting the selective criteria we used when triangulating locations. Sometimes we did not locate females frequently because they moved beyond the perimeter of the area we searched regularly and sometimes females used parts of the study area that blocked their transmitters' signals, leading to an unknown bias in our estimates of their movements. Female fishers do not travel as widely as do males, however, limiting the effects of bias, if it existed (Powell 1994). At the end of 2013, we were actively tracking 17 female fishers.

We outfitted adult male fishers with Platform Terminal Transmitter (PTT) collars that work with the Argos satellite system and were made by SirTrack (Havelock North, New Zealand). The satellites tracked these collars even when conditions did not permit ground tracking and, thereby, obtained more location estimates per male fisher than we obtained per female using VHF telemetry. Young males are not good candidates for wearing collars because their necks may grow rapidly. During the course of 2013 we followed a total of 10 males, starting the year with 7 and ending the year with 5. In 2012 and 2013, we outfitted a small number of males with Global Positioning System (GPS) collars programmed to locate themselves every 10 minutes (Lotek Wireless, Newmarket, Ontario). These males had been injected with doubly-labelled water, allowing us to calculate their field metabolic rates.

Although the batteries in the Argos collars should last over a year, some collars have failed before their projected lifetime. Most failures whose cause of failure we documented were caused by fishers chewing and, thereby, shortening the transmitter antennas. A few collars dropped from fishers early in the research due to failed attachment bolts, a problem that we have resolved. Despite pre-mature failures, the Argos collars have provided location data that we simply would not have obtained using traditional VHF technology. For example, 1 male traveled into the Central Valley north of Chico twice during early 2011, ultimately returning to the general area of his release. We would never have tracked those long-distance forays into the Central Valley using traditional technology. On the whole, the Argos collars on male fishers have functioned for long periods and have provided location data at higher rates and with less bias than possible with VHF transmitters.

We averaged 138 ± 215 locations/male/year across all study years and 141 $\pm$ 115 locations/male in 2013 (Table 2). All Argos location estimates are classified into 1 of 6 error classes, some of which will be suitable for some analyses but not others. On average individual males averaged 103 $\pm$ 124 locations/male/year from the 2 categories with smallest error and 50 $\pm$ 62/male in 2013 (Table 2).

Triangulations constitute the majority of estimated locations of females and young males. For fishers tracked with VHF telemetry, approximately 80% of all estimated locations were triangulations. Another 10% of VHF locations were estimated from fixed-wing aircraft or a helicopter and 10% were "walk-ins". Walk-ins included visual observations of fishers and locations of identifiable den or rest trees. Walk-ins also included trapping locations, mortality locations, and locations where fishers dropped collars. We have identified 113 den sites through the 4 denning seasons; we re-located fishers at some dens trees often. Additionally, we have located >150 individual rest locations; >90% of these were in trees, though some fishers rested under rocks, in stumps or in debris piles. Locating rest sites is biased towards finding sites in trees because fishers in trees broadcast strong telemetry signals. Location information from cameras at dens and baited stations will also be incorporated into final analyses, but those data have yet to be incorporated into our locations database.

Understanding and estimating error for our triangulations is a critical component of future analyses. We will evaluate triangulation error in two ways: 1) calculating triangulation error for test collars in known locations (both moving and stable; n ≈50) and 2) comparing triangulations to "walk-in" locations for fishers that were located on the same day (usually with the same hour) in den and rest trees. A preliminary analysis of triangulations *vs* walk-in locations yielded a mean error of 102 ± 132 m. These are preliminary results since we are finalizing protocols and software for estimating locations using triangulation. As part of our final analyses, we shall test for relationships between triangulation error and other variables, such as azimuth angle, weather, etc. As with triangulations, we

estimate error of aerial locations by having personnel who do not know the known locations of transmitters locate those transmitters. All walk-ins provide fine-scale (<20 m) information about fishers locations.

We are able to assess true error rates for Argos locations of each error class by comparing satellite locations to known locations of males held in captivity, of collars that have been dropped (the day they are dropped is known from activity data), or of dead fishers. The mean error for Argos locations estimated across all error classes is 767 ± 1241 m. Our calculated mean error for locations in each error class are consistent with expected error predicted by the Argos service (Sauder et al. 2012; Table 2). Locations in error classes 3 and 2, predicted to have the least error, have mean error of 195 ± 247 m and 458 ± 460 m (± SD). Location estimates from the error class 3 had a maximum error of 2400 m but 91% of locations were within 350 m of the true location. Future analyses will attempt to understand better how environmental factors influence error and how we can implement other metrics provided by Argos (e.g., error radius and geographic dilution of precision [GDOP]) to eliminate locations that are highly inaccurate.

We have attempted to monitor fishers during all times of day and night to ensure that our information is not biased to one time period. VHF transmitters are more difficult to locate at night, particularly in the winter when temperature, weather and road conditions hinder access to the study area. Thus, the majority of VHF telemetry locations have been collected during daylight hours (8 am to 4 pm; Figure 4). We have programmed Argos collars to be located during different times of day, leading the distribution of locations of fishers wearing those collars to be relatively even across all times. We programmed GPS collars to locate themselves across all times of day, leading to a very even distributions of locations.

We are collecting enough location data to estimate annual home ranges for most fishers. Thirty locations represent a reasonable minimum sample size for estimating home ranges with fixed-kernel methods, though more locations is preferable (Fieberg and Börger 2012, Seaman et al. 1999, Noel 1993, Seaman and Powell 1996). We have more than 100 estimated locations per year for many fishers.

We believe that an animal's home range is that part of the landscape in which it lives that it maintains updated within its cognitive map of the landscape (Powell and Mitchell 2012). For this report, for logistic reasons, we assume that 95% utilization distributions for fishers' use of space provide reasonable estimates of home ranges. We have estimated utilization distributions using a fixed kernel smoothing program. Such programs smooth data using a kernel and a smoothing parameter, "h", whose values are, ideally, related to aspects of the biology or management goals for the animals being studied. Silverman's (1990) kernel "k2" is a bell-shaped kernel with finite bounds, is leptokurtotic and, therefore, resembles the distribution of telemetry error for experienced researchers; we use "k2". Many researchers choose "h" to minimize internal error within a distribution of location estimates, and we have advocated this approach in the past (Seaman and Powell 1996, Powell 2000). Such choice of "h", however, ignores the biology of the animals studied, chooses different values for "h" for different animals, and even for different random samples from a single data set, making comparisons between studies nearly impossible. For fishers, different values of "h" provide insight into different aspects of their biology. For our fishers, h=750 m appears to estimate reasonably well the probability of where a researcher will be able to find a given fisher using telemetry. Average daily movements of fishers suggest that 1500 m should estimate where a fisher can travel over the coming day. Average distances across distributions of location estimates suggest that 1000 m will estimate the overall range of space a fisher uses but not its small scale preferences. Values of "h" tailored to match the estimated error for each location estimate should provide the best estimates of fishers' habitat preferences. Table 3 shows mean estimates for 95% utilization distributions for 2011-2013 using h = 750, 1000 and 1500. Figures 5 and 6 show the home ranges of female fishers on Stirling in 2013 calculated with h=750 m and h=1500 m.

Table 3 shows that males have larger areas of use than do females, that larger values for "h" lead to larger utilization distributions, and that areas used by fishers decreased from 2011 through 2013. We hypothesize that

utilization distributions decreased over time *not* because fishers actually used less space in successive years (we actually hypothesize that they used more space) but because as their population density grew, fishers could not pick and choose good habitat patches as freely as they could when fewer fishers were on the landscape and, therefore, confined their use of habitats within smaller circumferences. Future work will focus extensively on predicting and understanding space-use by fishers on Stirling.

Daily tracking of fishers suggests that females established home ranges primarily within Stirling (Figure 7). Some females have travelled to adjacent Forest Service or private lands and one traveled north ≈22 km onto the Lassen Management Area of Sierra Pacific Industries; she died, however, within 3 months of release. Additionally, female fishers have denned in trees on both the Lassen and Plumas National Forests, but usually within 2 km of the Stirling border. One female born on site and initially captured in early 2012 established a home range primarily off Stirling in the Rock Creek area which borders both the Lassen and Plumas National Forests.

Male fishers have also established home ranges over most of Stirling. Since males have larger home ranges than females and disperse more widely, they have been located on adjacent lands more often than females. Several males have established home ranges off Stirling (Figure 7) and up to 40 km from where they were released. The distribution of the male fishers we have tracked suggests that males that we no longer track may have a substantial presence on forest service, private timber lands and SPI holdings adjacent to or near Stirling. We have not tracked most juvenile males born on Stirling that have, or will, disperse long distances and, consequently, we do not know how far away males that originated on Stirling may establish home ranges.

POPULATION MONITORING ON STIRLING

From 12 October through 16 November 2013 we conducted a large-scale trapping effort on Stirling to capture as many fishers as possible and to outfit or re-outfit these fishers with functional transmitters. We spread our trapping effort across that part of Stirling and adjacent lands that we cover regularly during fieldwork, focusing on areas where fishers were known to live or had been previously detected. To maximize efficiency, we split the study area into east and west of Butte Creek. We trapped the east side for 14 trap days (10-26 October), then moved to the west side (27 October - 16 November), planning also to trap for 14 days. Trapping success was low on the west side was exceptionally low and really wanted to recapture a male who had been labelled with doubly-labelled water and was wearing a GPS collar, and some females who needed their collars changed but had not yet been caught. Therefore, we extended trapping at specific sites on the west side. Logistical constraints precluded or curtailed trapping in some areas we were certain had resident fishers.

Across the entire study area we deployed nearly 100 traps during each trapping period, totaling 3172 trap days (1442 east, 1730 west). We totaled 34 captures of 22 individual fishers, (17F, 5M) yielding 1.1% trap success. This success rate was considerably lower than our 1.9% success in 2012 but is within the range for our success for trapping fishers to reintroduce onto Stirling. As we experienced in 2012, trap success was greater on the East side (1.7%) than on the West (0.6%). We captured 7 new fishers (6F, 1M), capturing 3 of the new females twice each. We were surprised to capture so few males, since male mustelids are notoriously easier to catch the females (King & Powell 2007). We recaptured 1 female released in year-1, 2 females and a male released in year-2, 3 males released in year-3, 3 females born on Stirling in the 2011 cohort, and 5 female and 2 males born on Stirling in the 2012 cohort. The female we recaptured from the year-1 release was in average health and still retained her implant. The implant was surgically removed and despite being in her abdomen for over 3 years, had caused no obvious tissue reactions. That implant had failed in August of 2010 and we had been unable to document whether she produced kits earlier in that year. Her teats showed that she produced kits in the intervening years. She was recaptured near her last known location from summer 2010 and we re-collared her. We recaptured her nearby a few days later and we have collected many triangulation-based locations on her since.

We captured a total of 83 non-target carnivores, for a capture rate of 0.3% (Table 4), considerably lower than capture rate for non-target carnivores in 2012 (1.2%). As for fishers, the capture rate for non-target carnivores was higher on the east side (0.3%) than on the west side (0.2%). We had a notable capture of a bobcat squeezed tightly into a trap set between Butte Meadows and Jonesville. This bobcat had a compound fracture of his right foreleg that was not an injury from our trap, though he may have struggled into our trap because he was having troubling catching prey and was hungry. We sent him to a facility in Sonoma for care and rehabilitation and he has since been released at his capture site and is being tracked via a satellite collar by DFW

Of the 17 female fishers captured, 12 were given new collars (Telonics MOD-125). All adult males received new collars (Sirtrack Kiwisat 303 or Lotek Minitrack GPS collar). Fishers have dispersed widely across Stirling now and limited personnel and other resources prevent us from tracking them all consistently. Therefore, prior to trapping in 2012, we decided to collar only animals that were captured near fishers that we were already tracking. We failed to capture 6 females whose transmitters were still functioning. Even when we placed traps within the known home ranges of these females, we could not capture them. In addition, capture success decreased continuously during the trapping period concurrent with progressively warmer and drier weather. Clearly, we did not capture all fishers that were within the trapping area.

We labelled 4 females and 1 male with doubly-labelled water (water having heavy hydrogen, Deuterium, and heavy oxygen, ^{18}O) and then recaptured them, which will allow us to calculate their field metabolic rates for the period between captures. These data will allow us to test Powell's (1979) model for energy expenditure by wild fishers.

At the conclusion of trapping in 2013, the age structure of the known fishers on Stirling emphasized young, fishers (Figure 8). Fishers < 2 years old comprise 50% of all fishers known to be alive. Many fishers older than 2 years of age are still in the population, but the young age structure suggests healthy reproduction and recruitment. The age distribution in Figure 8 is our best estimate of the true age distribution of the Stirling fisher population and is accurate only to the extent that our trapping results were representative for the population.

In mid-November 2013, after our fall trapping effort, the minimum known population size of fishers on Stirling was 30 (total fishers captured + non-captured fishers wearing functional transmitter collars), which is lower than the minimum population sizes calculated after trapping in 2012 (n=38) and 2011, (n=32). We could not estimate population size using a capture-mark-recapture approach, as we have done in previous years, because of our low capture rate. We believe that the best explanation of our low capture rate and, therefore, our low minimum population estimate, is that warm, dry weather during trapping caused fishers to move to areas that were difficult to trap, such as in cool, deep canyons lacking road access, and that they reduced movement to stay cool and to save energy. Several lines of evidence support this argument. Fishers are generally difficult to catch during summer, when weather is warm. Second, our capture rates for other carnivores were even more depressed than was our capture rate for fishers and we know of no reason why all medium-sized carnivores should have decreasing populations on Stirling. Third, we have continued to capture young fishers born on Stirling and the age distribution of known residents emphasizes young fishers. Finally, fishers reintroduced onto Stirling and have gained weight and young fishers on Stirling weigh more than young fishers we captured elsewhere.

Nonetheless, our low trapping success and low minimum population estimate are cause for caution. Facka et al. (in preparation) have simulated reintroduced fisher populations, showing that following the populations in the years after releases are complete is critically important (Figure 9). If a population has been reintroduced into an area with poor habitat that is, ultimately, unable to support a healthy fisher population, problems of decreasing population size will not be apparent until the years after releases are finished. Consequently trapping and non-invasive monitoring in future years will provide the valuable information needed to evaluate the success of the reintroduction of fishers on Stirling.

WEIGHTS AND WEIGHT CHANGES

We have recaptured 17 (8 F, 9 M) fishers on Stirling >10 months after release. Thirteen (76%) of recaptured fishers had increased in weight since release. Females gained an average of 0.2 ± 0.2 kg after initial translocation and males gained an average of 0.4 ± 0.4 kg. Some of the weight gain by males was simply due to juvenile males maturing but adult males did gain weight, too. The 95% confidence intervals for both female and male body mass change bounds zero suggesting that on average fishers did not gain weight after translocation. Statistically significant weight gain was documented after year-2 (Powell et al. 2012). The lack of apparent weight gain after year-3 is most likely due to fishers reaching a stable size. Nonetheless, most reintroduced fishers that we have recaptured have maintained or increased their weights, suggesting that they found sufficient food during the first 3 years of the study.

Juvenile fishers born on Stirling and captured in the falls of 2011 and 2012 weighed more than similarly aged fishers captured at our source locations in 2009-2011. Young female fishers (<24 months old) born on Stirling and captured in autumns of 2011, 2012 and 2013 weighed 2.1 (± 0.2 SD) kg compared to 1.9 ± 0.2 kg for juveniles captured at source locations. Young male fishers (<24 months old) born on Stirling also weighed more (3.6 ± 0.4 kg) than young males captured at source locations (3.2 ± 0.3 kg). Similar to reintroduced fishers, young fishers born on Stirling have been finding sufficient resources to survive and maintain body weight.

SURVIVAL

Through January of 2014, we confirmed the deaths of 16 fishers (10 F, 6 M). During 2010, premature transmitter failure limited our ability to document survival but we did document the deaths of 3 females. In 2011, however, we tracked all females continuously for the year or until death (1 F, 1 M). In 2012, we again tracked the majority of fishers for the full year and documented the deaths of 1 male and 5 females. In 2013 we documented the deaths of 5 males and 1 female. Trapping in the fall of 2013 allowed us to re-collar and to confirm the survival of several fishers whose transmitters had previously failed, including a female released in the first cohort. We used data from telemetry, trapping and remote cameras to examine patterns and rates of survival for reintroduced and Stirling-born fishers for December 2009 through January 2014.

We analyzed monthly survival using "known fates" analyses within program MARK (White and Burnham 1999). Known fates analyses account for each time period when fishers were known to be alive or were found dead. Fishers that we could not document as either alive or dead within any month were censored and, therefore, not used to estimate survival for that time period. We used Akaike's Information Criterion corrected for small sample size (AICc) to rank 11 hypotheses that could explain the pattern of mortalities and survival that we documented (Table 5).

We developed 16 hypotheses from 9 variables hypothesized to affect survival of reintroduced fishers and included a null hypothesis of constant mortality over time. The variables were 1) "Sex" (due to differences in size, movements, etc. between the sexes) 2) "Release" (reintroduced fishers differ in survival before and after establishing their home ranges), 3) "Reproduction" (females have high activity levels, which leads to high mortality, in April - August [the time of lactation and highest energy output by females, Powell & Leonard 1983], males have high activity levels, and greatest risk of mortality, in March – May to find females and compete with other males), 4) "Cohort" (year of release for released fishers, and the year Stirling-born fishers were captured), 5) "Reintroduction" (reintroduced fishers and fishers born on Stirling differ in survival), 6) "Maturity" (adults and juveniles [<1 yr old] differ in survival), and 7) Time (survival changes through time). Note, that time was generically tested where all months and years were hypothesized to have different rates of survival, but we also considered monthly (8} Month) and yearly (9] Year) changes to survival in addition to interactive and additive combinations of those characterizations of time. We also tested 7 hypotheses with combined variables: 1) "Reproduction + Maturity" (because juveniles do not reproduce, avoiding the costs of the

reproductive season), 2) "Cohort + Maturity" (because all fishers released were adults), 3) "Sex × Cohort" (sex-specific mortalities could differ between cohorts), 4) "Sex × Month × Year" (because sex-specific mortalities could differ among months), 5) "Sex + Year" (sex-specific mortality that is similar in pattern, but different in magnitude, through years, 6) "Month + Year" (patterns of monthly survival are similar in pattern, but different in magnitude, across all study years, and 7) "Sex + Month" (sex-specific patterns in monthly survival across years).

The highest ranked hypotheses, and the only with ΔAICc < 2, included the Reproductive season and Maturity (Table 5). The second highest ranked hypothesis included only the Reproductive season. Survival estimates are low for females during reproduction (0.95; 95% CI = 0.89-0.98) and for males (0.96; 0.88-0.99). During all other periods, estimated monthly survival rates were high for both sexes (0.99; 0.97-1.0). Incorporating the different survival rates for males and females during their respective reproductive seasons with high survival in other months leads to estimates of annual survival of 0.72 for females and 0.76 for males. Were survival constant across all months, our estimates of annual survival would be 0.78, but this model was not well supported (Table 5). We estimate survival of Stirling-born fishers after our live-trapping season in autumn to be 1.0 (1.0-1.0) because we have never documented a juvenile death. We have no good estimates of survival for juveniles before the autumn of their first year, however, when we first live-trap them and mark them individually. Thus, our estimates of juvenile survival are undoubtedly biased high for their whole first year. No other models had any ability to reproduce our data (Table 5). In general, survival is high for fishers throughout the year but reaches its nadir during the reproductive period. Seven (of 10, 70%) females died in April - August. One of those females was found dead in October but had not been located since August and, therefore, we dated her death to August. Additionally, 86% (6 of 7) females that died during the lactation period were clearly lactating or were known to have had kits in the months prior to their deaths. All documented deaths of males were in March - May, coinciding with the peak of their breeding behavior. We have no data that clarifies why fishers are more likely to die during this period. We doubt that reproductive behavior, per se, contributes significantly to mortality but the energy requirements of reproduction to travel long distances, either for males to find females or for females to find enough food to support lactation and to feed their growing young. During travel, fishers may be exposed to predators and if fishers have not met their energy requirements they may be prone to predation. This pattern of reduced survival during reproductive periods has been found in other studies of fishers in California.

We characterized the sites where we found fisher carcasses or partial remains and took photographs. All fisher carcasses with sufficient remains were necropsied by Leslie Woods, an experienced wildlife pathologist at the California Animal Health and Food Safety Lab at the University of California Davis, with the assistance of Deana Clifford or Mourad Gabriel (Integral Ecology Research Center). She examined all major tissues to identify lesions, and performed immunohistochemical, toxicolical, bacteriological, parasite, and virological diagnostics as needed. Carcasses that were severely decomposed or did not contain adequate viscera (partial remains) were not necropsied.

For any fisher carcass with evidence of predation, Greta Wengert (Integral Ecology Research Center) conducted molecular forensics to determine the species of predators that contacted the carcass and could have been responsible for killing the fisher (Wengert et al. 2014). Samples collected for predation analyses included hairs observed on the carcass that were thought to be from a predator (not fisher), matted fur (presumably matted with predator saliva) around apparent punctures caused by possible predator canines, and polyester swabs within all apparent puncture wounds caused by possible predators. When only partial remains were found, bones and the remaining transmitter (implant or collar) were sampled for genetic material from predators or scavengers. DNA was extracted from samples using DNeasy Blood and Tissue extraction kits (Qiagen, Valencia, CA, USA). Polymerase Chain Reaction (PCR) was run on each sample using primers specific to the families Felidae and Canidae; resultant PCR products were sequenced, and sequences were cross-referenced on GenBank to determine species identity. These methods have been used successfully on carcasses of 57 fishers (from multiple studies) killed by other predators to determine

predator species (Wengert 2014; G.M. Wengert, unpublished data). In cases where only scant remains were recovered, DNA from other species could have been associated with predation or scavenging.

Necropsies were performed on the carcass of a fisher that died in year-1 while being held in captivity and on 4 of the 11 fishers found dead after release (Appendix 1).

Liver samples from 4 of the 5 necropsied fishers were also tested for the presence of 7 different anticoagulant rodenticide compounds (anticoagulants). The carcasses of the remaining 7 fishers were too decomposed or lacked adequate tissue (partial remains) for necropsy and AR testing. Predation forensic analysis was used to confirm predator species for 1 necropsied carcass and was attempted for 4 carcasses that were decomposed or had only partial remains. Necropsy, predation forensics and toxicology findings for all fisher carcasses collected on the project to date are summarized in Appendix 1. Cause of death was identified for only 2 of the 6 carcasses submitted in 2012: a female fisher found dead a few days post-release in December 2011 had systemic disease of unknown origin and a female fisher found dead in June 2012 was predated by a bobcat (Woods and Wengert, unpublished). Predation forensics conducted on a female found in July of 2012 resulted in weak 17 amplification of felid DNA, thus additional testing is pending. Samples tested from 2 additional carcasses suspected to be predation cases did not amplify any predator DNA (Wengert, unpublished). These causes of mortality are consistent with other studies in California (M. Gabriel and G.M.Wengert, unpublished data), but our inferences from the data are limited by the lack of carcasses recovered in suitable condition for cause of death determination. Partial remains of 4 fishers (3M: 1F) were submitted to the DFW Wildlife Investigations Lab in 2013. None of the four carcasses had sufficient tissues to submit for necropsy or AR testing, thus cause of death and toxicant exposure was not able to be determined.

Three of the 4 fishers tested had anticoagulants present in their liver tissue. Two of these 3 fishers (the year-1 female that died in captivity prior to release and a year-3 female) were exposed to brodifacoum while the third fisher (a year-2 male) was exposed to both brodifacoum and bromadialone. For the 2 reintroduced fishers, anticoagulant exposure could have occurred prior to or post-release, as the half-life of these 2 second generation anticoagulants in liver tissues is >150 days (Vandenbroucke et al, 2008). No liver samples were available for testing from fishers that died in 2012 or 2013. Currently brodifacoum can be bought over the counter at most retail outlets (e.g. D-con products). Bromadiolone is most commonly used by professional applicators and is available at farm stores (Stella McMillin, CDFW, pers comm). The finding of multiple compounds in a single animal may indicate exposure from multiple source points or uses. The overall significance or potential impacts of sublethal exposure to anticoagulants in fishers and other wildlife are largely unknown, but widespread exposure and cases of direct mortality due to anticoagulant toxicity in fishers and other wildlife species has raised significant conservation concerns (Gabriel et. al 2012). To determine definitively if anticoagulant exposure is occurring at the reintroduction site, we will test liver samples from any recovered fishers that were born on Stirling.

We continue to radio-track and retrieve dead fishers as quickly as possible, since understanding survival rate is critical for understanding population dynamics, which is major objective of our research. To meet all of our goals, we are committed to locating all fishers on Stirling as often as possible to determine causes of mortality in the reintroduced population. Limitations on manpower, relatively few aerial surveys (<2 per month), and widely spaced individual fishers often preclude detecting and recovering dead fishers quickly. Future survival analyses will incorporate biologically relevant covariates (e.g., body mass, age, home range components), if possible, to yield a mechanistic understanding of the factors that affect survival of fishers on Stirling.

REPRODUCTION

Released fishers produced kits in all 4 springs since translocation, as have fishers born on Stirling since 2012, the first year these fishers reached the age of producing kits. Our daily searches for female fishers provided a good

knowledge base of their daily movements. When we located a female in a given area, especially in the same tree, on successive tracking occasions in late March and early April, we suspected that she had denned and given birth to kits. Monitoring via telemetry and remote cameras verified denning. In 2010, 63% of mature females denned, in 2011 78% did, in 2012 and 2013 90% did (Table 6). During years-2 and -3 a minimum of 10 females who had been released in years-1 and -2 denned successfully. Consequently, we know that these females bred after giving birth in their first year on Stirling. Since the only males available for breeding were those that had also been released, we know that at least some of the males we released were capable of breeding and producing kits. During year-3 we also documented females successfully denning that did not give birth in their first year on Stirling. Consequently, we know that females of various ages and previous reproductive histories have found sufficient resources on Stirling to bring litters from fertilization through parturition to independence. Because we do not find all dens and because remote cameras do not document all kits, we know that our data for reproduction are biased low at least to some extent.

In all years of the study we confirmed that kits were born and survived until their mothers moved them from their natal dens to maternal dens. We placed multiple infrared cameras around each den tree. Cameras catch much, but not all, movement of females, providing a minimum estimate of litter size. In 2010, minimum litter size averaged 1 kit, 2.2 kits in 2011, 1.8 in 2012, and 1.9 I 2013 (Table 6). Females produced a minimum of 4 kits total in 2010, 13 kits in 2011, 14 in 2012, and 17 in 2013. In 2012 several females chose den trees that restricted placement of cameras, thus limiting information on kits. We could not count the number of kits for 2 females who maintained dens long enough for us to know that they must have had kits. Two females died while they had kits in den trees in 2012. We documented a minimum of 2 kits for 1 of these females but never documented a minimum litter size for the second. In neither case could the orphaned kits be rescued, though we attempted rescues at the last known den for each female. Using cameras and live-trapping, we documented that at least 23 kits survived to be independent of their mothers. Though we cannot track juveniles from birth through independence, and thereby provide a robust estimate of juvenile survival for that time, we have documented that some juveniles have reached independence. Our data document that a minimum of 48 kits were born across all 4 years.

Female fishers breed in March or April, only 7-10 days following parturition, and then experience a long delayed implantation, giving birth nearly a year later. Blastocysts implant on average in February. Before this reintroduction started, therefore, we hypothesized that releasing pregnant females in February through March would prevent them from denning and producing kits that year. Consequently, we planned to release all fishers during all 3 years during October-December. We were unable to capture and clear enough fishers for release before January in years-1 and -2 and, therefore, released some fishers in January and early February. In year-1, all females released prior to January (n = 3) denned successfully, whereas only 1 female of 5 that we released in January-February denned. In year-2, all females released prior to January denned successfully but only 2 of 4 released in January-February. In year-3 we released all females prior to January. Two females died prior to denning season, and one female was later estimated as too young to produce kits. Of the remaining 5 females, 4 (80%) denned successfully as we predicted in the Annual Report for 2011 (Powell et al. 2012). Despite our low sample sizes, the proportions of females released before *vs* after the New Year that den differs significantly. We are collaborating with researchers following the fisher reintroduction on the Olympic Peninsula (Lewis et al. 2010) to test our hypothesis and we have modelled the potential effect of release time on reintroduction success (Figure 9). Our data and our models suggest that releasing all female fishers before New Years should usually lead to faster population growth for reintroduced populations.

We documented females denning across Stirling as well as on other private lands and on national forest lands (Figure 10). Of 100 natal and maternal den trees that we found in 2010-2013 (Table 7), black oaks (*Quercus kellogii*) were most common for both natal and maternal dens (50%; Table 7). Female fishers used Douglas-firs (*Psuedotsuga menziesii*), incense cedars (*Calocednus decurrens*) and white firs (*Abies concolor*) in similar numbers (13%, 12% and 11%),

and other trees were less commonly (≤6%; Table 7). Fishers used both live trees (20 of 28 dens) most often as natal dens but, later in the denning season as kits began to travel with their mothers, females used snags a bit more often than live trees for maternal dens (36 and 30 of 72 dens) and even used hollow logs and piles of debris as dens or rest sites (6 of 72). In 2910-2012, SPI committed resources to collect data on vegetative and topographic characteristics within 90 m of den sites. Future analyses will examine patterns of female denning and movements (locations and timing) relative to topography (temperature related movements), time of year, predators and other factors that might influence female decisions to establish and move dens.

FOOD HABITS AND SMALL MAMMAL SAMPLING

We have documented the prey that fishers eat through various methods in both the field and in laboratory studies. Capturing fishers, as well as tracking them to rest and den sites, allows us to identify the remains of prey found near these trees, and cameras placed at den trees provide photographs of females returning with prey items. Field identification of prey types indicate that the fishers on Stirling eat diverse prey, including alligator lizards (*Elgaria coerulea*), gray squirrels (*Sciurus griseus*), California ground squirrels (*Otospermophilus beecheyi*), woodrats (*Neotoma* sp.), Douglas squirrels (*Tamiasciurus douglasii*), and other small mammal prey species. We have evidence that fishers may raid the nests of bird species as well. We have observed fishers returning to den trees with bird eggs and immature chicks of different species. In one instance we have documented a female fisher returning to a den tree with an unknown food item while a red-tailed hawk (*Buteo jamaicensis*) is seen approaching the fisher through the air. This may indicate the fisher had taken a nestling hawk. Fishers prey on nestling hawks elsewhere (Erdman et al. 1998).

Juvenile fishers captured in autumn often have the remains of berries in their feces. Juvenile fishers are known to eat nuts and berries is other study sites, and we hypothesize that those young animals supplement their diet because they are not experienced hunters (Powell 1993, Golightly et al. 2006). Since the inception of the reintroduction program, we have collected over 500 fisher scats that we began analyzing in 2013. Relatively few fecal samples are analyzed, but, in addition to species already reported, we have identified hairs from unknown species of shrews (*Sorex* sp.), spotted skunks (*Spilogale gracilis*), and unknown species of woodpecker (family Picidae). Thus far, we are unable to quantify the percent diet that any prey species, or guild of prey, comprises for fishers on Stirling . Analysis on the fecal remains is progressing and we shall quantify fisher diets in upcoming reports and publications. Through 2014 we will continue collecting information on fisher prey-use in the field as well as analyzing feces. We will use this information in conjunction with information on the occurrence, by land cover and habitat type, of prey types to test predictions of prey preference made by Powell (1993), and to understand better in what areas fishers are most likely to forage, and to understand the values to fishers of different parts of their home ranges.

Fisher prey type, abundance, and availability are important to understand and measure. In summer 2012, we established 42 plots to sample for small mammals across Stirling (Figure 10). We placed small mammal plots in areas where fishers had established home ranges and across a diversity of elevations (610 – 1530 m) and stands types with different canopy tree compositions and stand ages from young, regenerating stands to mature riparian zones. Our primary goals were to identify potential fisher prey and to collect data that could corroborate existing models and information on prey diversity (*e.g.*, California Habitat Wildlife Relationships), abundance, and their relationships to specific environmental and management features. Our trapping plots were designed across three spatial scales: plot-level (small spatial scale of roughly 30m), neighborhood (across all plots in a specific trapping area up to 2 km), and landscape (all plots and neighborhoods across the district). Using these three distinct scales we can evaluate the scale at which variability in occupancy and relative abundance of prey species is most responsive. While our sampling method is designed to focus on the capture of small mammals such as mice (*Peromyscus*), woodrats (*Neotoma*), ground squirrels (*Otospermophilus, Tamias*), flying squirrels (*Glaucomys sabrinus*) and tree squirrels (*Sciurus*, *Tamiasciurus*) we are also able to detect other species that do not readily enter traps through the use of remote cameras placed on each plot.

Plots were 30×30 m with 4 wire-mesh traps in each cardinal direction, 4 Sherman traps at each corner, and 1 of each trap type at the center of the grid (David Johnson, US Fish & Wildlife Service, Yreka, California, unpublished data). Each wire-mesh trap was tied to a tree roughly 1-2 m above ground to try and capture flying squirrels. Additionally, we placed a motion-sensitive camera 2-6 m away from the center traps to record other animals on plots.

In 2012, we captured 8 species of mammals (Table 8), primarily *Peromyscus maniculatus* (77% of captures). Other species were all captured at much lower rates. We incorporated these data on occurrence within an occupancy framework in program MARK (White and Burnham 2001) and tested several forest-related covariates to evaluate which, if any, best explained occupancy of these species. Among the covariates we examined, we included the percent of a stand that was coniferous, the basal area of a stand, canopy closure, differences between species, and time as predictors of occupancy. The best supported model indicated that the percent of a stand in coniferous trees explained occupancy best. Inference for most species we examined were not insightful (95% confidence intervals bounded 0); there was a negative relationship, however, between the percent of a stand in coniferous trees and the probability that a location was occupied for *Peromyscus* (β = -5.27 ± -9.46- 1.07) and *Neotoma* (β = -3.81 ± -677- 0.87). This result indicates stands with few hardwood trees are less likely to have either deer mice or woodrats present. Consultations with Dr. Ken Pollock (an expert in this approach) suggested that the overall design was sufficient to detect such relationships, but needed additional replicates (≈ 100 plots) to increase precision and inference. Consequently, we view the data, and analyses, from 2012 as preliminary and are planning on additional sampling in 2014 with the objective of increased sample size across the district. Over the next year we will include information from other sources including fall trapping for fishers, where some prey species are detected (see "Population Monitoring" section), baited cameras stations which detect species like hares (*Lepus* sp.) and flying squirrels, and from other non-invasive sampling methods used on the district. These variable methods should provide a robust understanding of what species occur in various habitat types and we will use these to compare to the types of prey fishers are using on Stirling.

HABITAT MEASURES AND ANALYSES

Because SPI has extensive forest inventory data for Stirling, we have not placed primary focus on gathering vegetation data. Nevertheless, we collected data on woody vegetation at 48 camera stations established in 2011 and 2012; at each of our 42 small mammal plots; at 10 den sites; at 19 female rests sites; and at 1 mortality site for a total of 120. Our objective was to validate model-based projections for vegetation using SPI data. We also collected data at some locations off Stirling and for which we would have limited information on vegetation if we do not gather our own.

Our data collection protocol was based on similar designs from previous studies and on the advice of other fisher researchers. On fixed 30×30 m plots we counted the number of all live and dead trees, shrubs, and we counted the pieces of downed woody debris along 4, 4-m wide,15-m long transects. We identified each tree or shrub to species and measured its diameter at breast height (DBH). At the center of the plot and at the end of each transect we measured canopy cover with a spherical densiometer. At each plot, we recorded slope, aspect, number of canopy layers, tallest tree height and species, distances to roads and water, and indices of visual obstruction. This sampling design provided metrics for each of 6 habitat models that we will test in future analyses.

For both camera and small mammal plots, we collected vegetation data within 3 weeks of their establishment. At den trees we collected data during the late spring or summer, after females had left. Thus, at den trees, data likely represent different conditions than experienced by the female fishers (*e.g.*, loss of snow, increased in canopy closure due to leaves) but at similar times to the data collected by SPI. These data will be included in analyses on fishers' associations with different land-cover types and in tests of habitat models.

ESTIMATING POPULATION PARAMETERS FOR KLAMATH FISHERS

The Klamath study area has 50 sampling units of 10.5 km^2 (4 mi^2), each containing 2 survey stations (Zielinski and Kucera, 1995; Figure 1). The Mt. Ashland section of our study area contained 42 survey stations, the Klamath River section 22, and the Collins-Baldy section 36. Only the Mt..Ashland and Collins-Baldy sections were surveyed in 2006.

We established survey stations near streams (seasonal or perennial) and on ridge tops with moderate to dense canopy and good airflow to increase the probability of fisher detection but not so far from forest and logging roads as to make access too difficult. Each survey station contained a 25x25x75 cm (10x10x30 in) tunnel made of Coroplast (corrugated plastic; Figure 11) Zielinski et al., 2006). The tunnel had a hardware cloth back to prevent entry or exit through the rear and 3 2x4 cm (1x2") boards in the front, starting 10 cm from the bottom of the front of the tunnel (Figure 11). The bottom board had a strip of non-poisonous glueboard attached underneath. Each tunnel was baited with a can of moist cat food and a piece of raw chicken. An animal wishing to enter the tunnel to reach the bait was forced to crawl under the bottom board and the glue strip captured hair. We installed track plates in half of the stations in 2007-2008 and in all stations in 2009-2011 and used the track plates to help identify station visitors.

The survey period started in mid-September each year and continued through mid-December in 2006-2012. Each station was checked once a week for 4 weeks. A survey week could be lost due to a tunnel being damaged by an animal (usually a black bear, *Ursus americanus*) such that a fisher could visit the station but not leave hair on the glue strip (removal of the glue strip, or the back screen opened, or the entrance blocked). Loss of a survey week resulted in the addition of a survey week, not to exceed a total effort of 42 days (6 weeks) for any station. Limited personnel (4 - 6 surveyors each year) and weather required us to stagger the running of survey stations. We started surveys at high elevation stations and finished at low elevation stations, making 2 sessions of data collection: mid-September to end of October and end of October to mid-December. We started surveys at all stations early enough, however, to allow 6 full weeks (if required) before the anticipated onset of snow deep enough to prevent access. Some mid-elevational stations were not consistently assigned to one session or the other due to logistical and personnel constraints in given years. In 2013, we check all stations concurrently for a 6-week period from mid-September through October.

We considered any hair attached to a glue strip to be a sample. We placed each sample in a desiccant-filled vial in the field to preserve sample integrity. If a gluestrip was destroyed or lost, we collected any loose hairs and fragments of gluestrip found inside and around the sampling tunnel. Surveyors handled samples in the field according to guidelines provided by Rocky Mountain Research Station of the USDA Forest Service in Missoula, Montana. Once a week, we batch-shipped samples overnight to the Research Station.

To optimize amplification, 10 hairs with roots (follicles) were used in the DNA extraction. In cases where we had fewer hairs in the sample, however, we used what was available (with or without follicles). Genotyping was performed using the multi-tube approach recommended for non-invasive samples (Taberlet et al., 1996). Specifically, we amplified each sample 2 times at each locus. If we failed to obtain consensus scores we amplified the sample an additional 3x (Schwartz and Monfort, 2008). If these three scores did not prove to be consistent we discarded the samples. We subsequently used several tests in program DROPOUT (McKelvey and Schwartz, 2004) to screen for potential errors. Samples identified as putative errors were re-amplified an additional 3x. In addition, after the multi-tube test and the DROPOUT screens we used field information in GIS to evaluate the likelihood of observing a recaptured genotype in a given location (Marucco et al., 2011).

We received data each spring from RMRS that included the individual identification for each fisher sample that could be assigned to an individual, its sex, and its haplotype. We estimated all demographic variables using Program MARK (version 6.2; Cooch and White, 2010; White and Burnham, 1999). We ranked evaluated biological hypotheses models (usually referred to as "models" in mark-recapture literature) using Akaike Information Criterion adjusted for small sample size (AICc). The model with the lowest AICc was considered the best fit, balancing a

tradeoff between precision and bias. The relative fit of models was evaluated using the difference in AICc between the model in question and the most supported (ΔAICc). Models with ΔAICc ≥ 4 were considered to have minimal support in the data (Cooch and White, 2010; White and Burnham, 1999).

Violations of the assumption of a closed population are an unfortunate consequence of sampling during the dispersal season for fishers (Powell, 1993), of fishers' home ranges being large and overlapping the boundary of the study area (Davis et al. 2007, Fuller et al. 2001, Powell, 1994, Powell and Zielinski 1994), and of the lack of consistency for the times across years that each station was run. We, therefore, modeled abundance using POPAN models to investigate transient animals. We used 2 Pradel variants of Jolly-Seber models to model recruitment and population change. We expected the population growth rate, λ, to be roughly 1, indicating a stable population throughout the duration of the current study. We used program TRENDS (Gerrodette 1987, 1993) to investigate what power would we need to detect a 10% per year decline in the population size and what was the minimum rate of annual population decrease we could detect with 90% probability.

We identified 22-32 individual fishers in the study area each year, totaling 125 over the entire period from 2006 through 2013. We detected between 14 and 21 new individuals each year, and 22 individuals were detected in the size-restricted study area in 2006. Apparent survival rate for fishers did not vary across years and was 0.60 (95% CI 0.50-0 - 0.69). Apparent per capita recruitment rate was 0.45 (0.34 - 0.57) and constant across years. Population estimates ranged from 45 to 52 and population growth rate was constant across years. Population growth rate was estimated to be 1.06 (0.97 - 1.15), suggesting a stable or slightly growing population, which is consistent with a recruitment rate (0.45) slightly higher than the mortality rate (1 – 0.60 = 0.40).

The surveys through 2012 were designed to estimate occupancy and allowed survey stations to be sampled in a temporally disjunct fashion. We were able to estimate abundance from the data but only with large confidence intervals. Robust Design mark-recapture estimates of abundance require stations need to be sampled concurrently. Occupancy, abundance, survival and other demographic parameters can then be estimated with greater precision. In 2013 we initiated concurrent sampling of all survey stations. A test of this new protocol requires data through 2016.

EVALUATING THE REMOVAL OF FISHERS FROM A SOURCE POPULATION

After we completed surveys in 2009 and in 2010, we removed 5 and 4 fishers each year for the reintroduction. Because we live-trapped fishers after our surveys in 2009 and 2010, the potential existed to see the effects in the 2010 and 2011 surveys. The removal of 4-5 breeding adults in each of 2 years was not detected in our abundance estimates, though the precision of our estimator was not high. The number of new fishers detected each year compared to the number of surviving residents, and the estimated mortality and recruitment rates, suggest high turnover within our population. While confidence intervals were large for our abundance estimates, all estimates of demographic variables suggest that the population of fishers in our Klamath study area was stable despite the removal of approximately 10% of the population each year. Removing breeding age adults, however, has the potential to affect recruitment in subsequent years, meaning a complete picture will require data through 2014. We calculate that we had a 67% chance of detecting a population decrease of 10% per year at $\alpha = 0.10$ and the minimum rate of population decrease we could detect with 90% probability was 29% per year.

DESIGNING A NON-INVASIVE PROTOCOL FOR STIRLING

In 2013 we initiated a pilot project of non-invasive sampling of fishers on Stirling with the goal of estimating population parameters without having to live-trap fishers and follow them using telemetry. The protocol for this pilot project on Stirling included 2 important differences from the protocol initiated on the Klamath study area in 2013. First, to ensure completeness of data collected, all sites were sampled for the maximum allowed 6 weeks, regardless of whether a station was rendered inoperable or not. Second, the Klamath data analyzed by Swiers (2013) showed that

more effort would be required to enhance the power of the survey design. A third survey station was added to each10.4-km^2 sampling unit. Sites were deployed on 18-21 September and retrieved on 29-31 October 2013. Seventeen units were planned for the survey, but lack of personnel required the number to be reduced to fifteen. All survey units were on the "West Side" of Stirling (Figure 12).

Each survey station had a track plate / hair snare box, and one station in each unit had two cameras. One camera was a project owned Reconyx PC800 and the other was an SPI owned Moultrie. The purpose for the cameras was to test a detection method other than those used on the Klamath study area and to truth genetic and track plate data. We used types of cameras to test for differences in detection rates.

Of 140 samples sent to the Rocky Mountain Research Lab for genetic identification, 28 were identified as fisher, and 25 of those were of a high enough quality to provide individual identification (89%). Those 25 detections were of 12 individual fishers, 3 males and 9 females. All 3 males were known and wearing functional Argos telemetry collars. Of the females, 4 were wearing VHF telemetry collars and the remaining 5 were unknown. The unknown females, however, could have been females trapped and collared during the annual live-trapping of October-November 2013. Of note, 12 of the 28 genetic detections of fishers lacked corresponding fisher track IDs (42%). For the 19 detections of fisher from tracks, 3 lacked corresponding genetic species IDs (16%). Cameras detected fishers 3 times without either corresponding fisher track or genetic IDs. In 2 of the 10 detections of a fisher with a Reconyx camera the Moultrie did not, though in 1 of those instances the Moultrie failed completely. And in 1 detection each via genetic species and track ID, we failed to get a photo of the fisher.

In all, we had 34 total detections of fishers that could be used to calculate occupancy. Aggregating the data from these detection methods translated into 2 functional positive detections at the unit level (our level of analysis). Genetic species ID provided the best information, though cameras were not placed on all sites. Each method shows some evidence of imperfect detection when we have positive data of fishers visiting sites.

We estimated abundance of fishers using Program MARK (White and Burnham 1999). Our highest-ranking model estimated a combined capture-recapture rate of 23% with a total of 15 fishers (SE 2.91, 95% CI: 12.5-27). This abundance estimate suggests that we may have encountered almost all of the fishers using the surveyed area. We recommend adding 12 sampling units in 2014, if possible, (Figure 12) and schedule sampling before live-trapping, if possible.

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Appendix 1. For fishers (*Pekania* [*Martes*] *pennanti*) released onto the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada, California, December 2009 - January 2014 identification (ID), sex, year of birth, age at the time of initial capture, month and year released onto the study site, weight at initial capture, whether the individual has been recaptured (and number of times if >1), weight at recapture (value is the mean if individual was recaptured more than once), number of months from time of release until January 2014, number of months the individual was tracked, the month and year of dead (if dead), and the cause of mortality if known.

ID	Sex	Year of Birth	Age at Capture	Release Year	Release Date (Mon-Yr)	Initial Wt (kg)	Recapture	Recapture Wt (kg)	Months Since Release	Months Tracked	Death Date	Mortality C
FEMALES												
199B9	F	2007	2	Year-1	Dec-09	2.2			37	18		
F6280	F	2008	1	Year-1	Dec-09	2.1			37	7	Jun-10	Possible bob
17ECC	F	2007	2	Year-1	Dec-09	2.4	Yes	2.3	37	8		
D00B0	F	2004	5	Year-1	Dec-09	2.5			37	7	Jul-10	Drowning (
17582	F	2008	2	Year-1	Jan-10	2.1			36	16		
19316	F	2006	4	Year-1	Jan-10	2.2			36	5		
F8B8D	F	2008	2	Year-1	Jan-10	2.0			36	6		
168F2	F	2007	3	Year-1	Feb-10	2.0			35	5		
F65B6	F	2008	2	Year-1	Feb-10	1.5			35	6	Jul-10	Possible bob
93B5A	F	2005	5	Year-2	Nov-10	2.2	Yes	2.2	26	23		
18FFF	F	2007	3	Year-2	Nov-10	2.1			26	10	Aug-11	Unknown
18871	F	2008	2	Year-2	Dec-10	2.1	Yes	2.4	25	25		
17FD8	F	2010	1	Year-2	Jan-11	2.2			24	24		
182F4	F	2010	1	Year-2	Jan-11	2.1	Yes	2.3	24	19	Jul-12	Possible felic
1E003	F	2008	3	Year-2	Jan-11	2.2	Yes	2.2	23	20		
21FB6	F	2009	2	Year-2	Jan-11	2.3	Yes	2.6	23	23	Jun-13	Suspect hea
20058	F	2010	1	Year-3	Nov-11	2.1	Yes	2.3	13	12		
23775	F	2008	3	Year-3	Nov-11	2.1			14	6		
1F111	F	2009	2	Year-3	Dec-11	2.0			13	6	May-12	Bobcat prec
2189C	F	2009	2	Year-3	Nov-11	1.8			14	10	Oct-12	Pending
21DFE	F	2011	0	Year-3	Nov-11	2.2			13	13		
252FD	F	2008	3	Year-3	Dec-11	2.1			13	1	Dec-12	Systemic dis
714C2	F	2008	3	Year-3	Dec-11	2.0			13	13		

IE03E	F	Uk[c]	Uk	Year-3	Nov-11	2.1			14	4	Feb-12	Unknown
21392	F	2011	0	Born on Stirling	Oct-11	2.1			15	15		
23955	F	2011	0	Born on Stirling	Oct-11	2.2	Yes	2,5	15	12		
1F955	F	2011	0	Born on Stirling	Oct-11	2.0	Yes	2.2	14	13		
209DD	F	Uk	Uk	Born on Stirling	Jan-12	2.3			12	12		
20950	F	Uk	Uk	Born on Stirling	Jan-12	1.9	Yes	2.3	12	12		
35978	F	Uk	Uk	Born on Stirling	Nov-12	1.9			2	2		
1EA8D	F	Uk	Uk	Born on Stirling	Oct-12	2.1			3	3		
242DB[b]	F	Uk	Uk	Born on Stirling	Oct-12	1.8			3	-		
36A8B[b]	F	Uk	Uk	Born on Stirling	Oct-12	2.0			3	-		
3828E	F	Uk	Uk	Born on Stirling	Nov-12	2.1			2	2		
397A3[b]	F	Uk	Uk	Born on Stirling	Nov-12	1.9			2	-		
614DF	F	Uk	Uk	Born on Stirling	Oct-12	2.3			3	3		
6178F	F	Uk	Uk	Born on Stirling	Oct-12	2.2			3	3		
MALES												
596E2	M	2005	5	Year-1	Jan-10	4.1	Yes	4.3	36	20	Sept-13	Suspect avia
16848	M	2007	3	Year-1	Jan-10	4.5			36	6		
181F9	M	2009	1	Year-1	Jan-10	3.4	Yes (#2)	4.4	36	13		
18308	M	2008	2	Year-1	Jan-10	4.2	Yes (#3)	5.3	36	26	May-12	Unknown
F0858	M	2006	4	Year-1	Jan-10	4.1	Yes	4.5	36	15	June – 13	Unknown
FB7DA	M	2007	3	Year-1	Jan-10	4.2	Yes	4.4	36	8		
F605B	M	2008	2	Year-2	Nov-10	3.3	Yes	4.1	26	11		
58985	M	2007	3	Year-2	Nov-10	4.5	Yes	4.7	26	7		
18CC8	M	2006	4	Year-2	Nov-10	3.6	Yes	4.4	26	26		
18C3E	M	2006	4	Year-2	Dec-10	4.5		5.3[a]	26	4	Mar-11	Road kill
18AA5	M	2005	6	Year-2	Jan-11	4.2	Yes	4.1	24	24		
22526	M	2007	4	Year-2	Jan-11	5.3			24	3		
24315	M	2010	1	Year-3	Nov-11	3.5			14	12		
1E10F	M	2011	0	Year-3	Dec-11	3.7	Yes	4.3	13	4		
IE14C	M	2009	2	Year-3	Nov-11	3.9			14	5		

IEC04	M	2010	1	Year-3	Dec-11	4.1			13	7			
24033	M	2011	0	Born on Stirling	Oct-11	3.6			15	6			
24101	M	2011	0	Born on Stirling	Oct-11	4.1	Yes	4.3	15	15	April-13	Unknown	
1FE60	M	2011	0	Born on Stirling	Oct-11	3.5	Yes	4.3	15	14			
2305B	M	2011	0	Born on Stirling	Oct-11	4.0			15	14			
38909	M	Uk	Uk	Born on Stirling	Nov-12	3.4			2	2			
64311	M	Uk	Uk	Born on Stirling	Oct-12	3.2			3	3			
1E613	M	Uk	Uk	Born on Stirling	Nov-12	3.8			2	2			
24B09[b]	M	Uk	Uk	Born on Stirling	Oct-12	3.5			3	3			
39A7E[b]	M	Uk	Uk	Born on Stirling	Oct-12	3.3			3	3			
3AD54[b]	M	Uk	Uk	Born on Stirling	Oct-12	3.0			3	3			

[a]Weight when recovered dead

[b]Fisher was not given a transmitter

[c]Unknown

Table 1. Mean numbers (±SD, N) of estimated locations per individual fisher per year across all years of study and 2013 organized by location method. Means are for individual fishers who were followed using each particular method. The research was conducted on or near the Stirling Management area owned by Sierra Pacific Industries and located in the Northern Sierra and Southern Cascade Mountains of Northern California.

Sex	Year	All Locations	Triangulations	Walk-ins	Flights	GPS	All Argos	Argos LC2+3
F	All years	36.8 ± 35.8, 82	32.1 ± 31.0, 74	4.5 ± 5.9, 70	4.8 ± 3.0, 66			
	2013	61.2 ± 43.9, 20	53.0 ± 39.4, 20	4.6 ± 2.8, 14	6.6 ± 2.2, 15			
M	All years	138 ± 215, 65	14.3 ± 14.4, 14	1.6 ± 0.9, 43	2.0 ± 1.6, 11	193 ± 396, 5	188 ± 206, 41	103 ± 124, 20
	2013	141 ± 115, 11	4.5 ± 0.7, 2		1.0 , 1		154 ± 112, 10	50 ± 62, 10

Table 2. Classes for Argos locations of male fishers, error predicted by Argos services for locations in those classes, our mean observed error, standard deviation (St Dev), minimum error observed, the maximum error observed and the total number of location estimates for each location class across all years (2009-2012) on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California. Data are from 17 tags at 26 locations.

Location Class	Predicted error	Mean (m)	Standard Deviation	Minimum (m)	Maximum (m)	n
3	<250 m	196	248	10	2482	431
2	250 – 500 m	458	461	10	3630	242
1	500 – 1500 m	1387	1227	34	6439	123
0	>1500m	2566	1730	58	7055	30
A	none	811	1128	10	6061	192
B	none	1289	1788	17	8744	349

Table 3. Mean areas (± SD) for 95% fixed kernel utilization distributions (UD) of fishers on Stirling in 2011-2013 using different smoothing parameters and Silverman's K2.

		Mean UD + SD (km^2)	
Smoothing parameter (m)	Year	Females	Males
750	2011	25.0 ± 4.7	80.5 ± 37.4
	2012	16.0 ± 5.3	41.9 ± 23.0
	2013	14.2 ± 4.6	41.3 ± 18.7
1000	2011	34.4 ± 6.5	107.0 ± 40.8
	2012	20.6 ± 7.8	57.5 ± 31.7
	2013	17.4 ± 5.6	53.9 ± 24.2
1500	2011	52.8 ± 9.7	152.8 ± 42.6
	2012	29.2 ± 12.6	85.5 ± 46.7
	2013	23.5 ± 6.9	76.0 ± 35.7

Table 4. Number and percentage of total non-target carnivores captured during fall trapping of 2013 on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California. (We also captured 2 woodrats and 20 douglas squirrels.)

Species	Common Name	Number	Percent of non-targets
Lynx rufus	Bobcat	1	1.2%
Mephitis mephitis	Striped skunk	1	1.2%
Didelphis virginianus	Opossum	4	4.8%
Urocyon cinereoargenteus	Grey fox	14	16.9%
Bassariscus astutus	Ringtail	23	27.7%
Spilogale gracilis	Spotted skunk	40	48.2%
TOTAL		**83**	

Table 5. Model selection comparison for 11 models of survival from a known fates analysis in program MARK based on monthly fates of reintroduced fishers and their offspring in the Northern Sierra Nevada of California, December 2009 – January 2014.

Model	AICc	Delta AICc	ΔAICc	Likelihood	K	Deviance
Reproduction + Maturity	151.8	0.00	0.84	1.00	4	82.21
Reproduction	156.9	5.09	0.07	0.08	3	89.32
Reintroduction	158.3	6.57	0.03	0.04	2	92.82
Control (Null)	159	7.23	0.02	0.03	1	95.48
Cohort	160.6	8.81	0.01	0.01	4	91.02
Release	160.8	9.09	0.01	0.01	2	95.33
Sex	161	9.23	0.01	0.01	2	95.47
Sex + Year	162.3	10.55	0.00	0.01	8	84.63
Year	164.3	12.50	0.00	0.00	4	94.70
Cohort + Maturity	164.3	12.58	0.00	0.00	6	90.73
Sex × Cohort	167.1	15.36	0.00	0.00	12	81.22
Month	171.8	20.08	0.00	0.00	12	85.94
Month + Year	175.5	23.72	0.00	0.00	14	85.44
Sex + Month	183.8	32.04	0.00	0.00	24	72.75
Time	220.5	68.75	0.00	0.00	50	52.23
Sex × Month × Year	320.2	168.44	0.00	0.00	99	32.53

Table 6. The number of females that were radio-tracked, the number that denned, the percent of females that denned, the minimum number of kits known to have been produced (Min # kits), the mean minimum litter size (Litter Size ± 95% CI), the ratio of kits known to have been produced to females (Kits/Female), the number of natal dens found, and the number of maternal dens found for year-1 females in 2010, for year-1 and -2 females in 2011, and for year2 and -3 females tracked in 2012 on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California.

	Year 1 2010	Year 2 2011	Year 3 2012	Year 4 2013	Totals
Females	8	9	10	10	37
Females denned	5	7	9	9	30
% Denned	63%	78%	90%	90%	81%
Minimum # kits[a]	4	13	14	17	48
Mean minimum litter size	1	2.2	1.8	1.9	1.5
Kits/female	0.5	1.4	1.4	1.4	1.2
Maternal dens tracked	23	13	20	17	82

[a] Calculated from females that we could document with kits from photographs.

Table 7. Numbers of den trees by species for natal and maternal dens from 2010 to 2012, and by condition of the den tree (live tree, standing snag, or other [e.g., downed log or debris pile]) on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California.

		Natal			Maternal			
Common Name	Tree Species	Live tree	Snag	Other	Live tree	Snag	Other	**Total**
White fir	ABCO	3	0	0	1	6	1	**11**
Red fir	ABMA	0	1?	0	0	0	0	**1?**
Incense cedar	CADE	1	1	0	4	4	2	**12**
Unidentified conifer	CON-UK	0	0	0	0	5	0	**5**
Tanoak	LIDE	2	0	0	1	2	1	**6**
Sugar pine	PILA	0	2	0	0	1	0	**3**
Ponderosa pine	PIPO	1	1	1	0	2	1	**6**
Douglas-fir	PSME	1	1	0	2	8	1	**13**
Canyon Live oak	QUCH	0	0	0	1	0	0	**1**
Black oak	QUKE	12	1	0	21	8	0	**42**
Total		**20**	**7**	**1**	**30**	**36**	**6**	

Table 8. Species, common name, total captures and proportion of total capture for all animals captured on prey abundance plots during summer of 2012 on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California.

Species	Common Name	Total captures	Proportion
Peromyscus maniculatus	Deer mouse	202	0.77
Neotoma macrotis	Big-eared woodrat	34	0.13
Tamias senex	Allen's chipmunk	9	0.03
Spermophilus beechyii	California ground squirrel	5	0.02
Sorex trowbridgii	Trowbridges shrew	3	0.01
Scapanus latimanus	Broad-footed mole	3	0.01
Elgaria coerulea	Alligator lizard	2	0.01
Sciurus griseus	Western Gray Squirrel	2	0.01
Oreortyx pictus	mountain quail	1	0.00

Figure 1. Eastern Klamath Study area. This study area lies in northwestern California and southwestern Oregon and has checkerboard ownership by public agencies and private timber management companies.

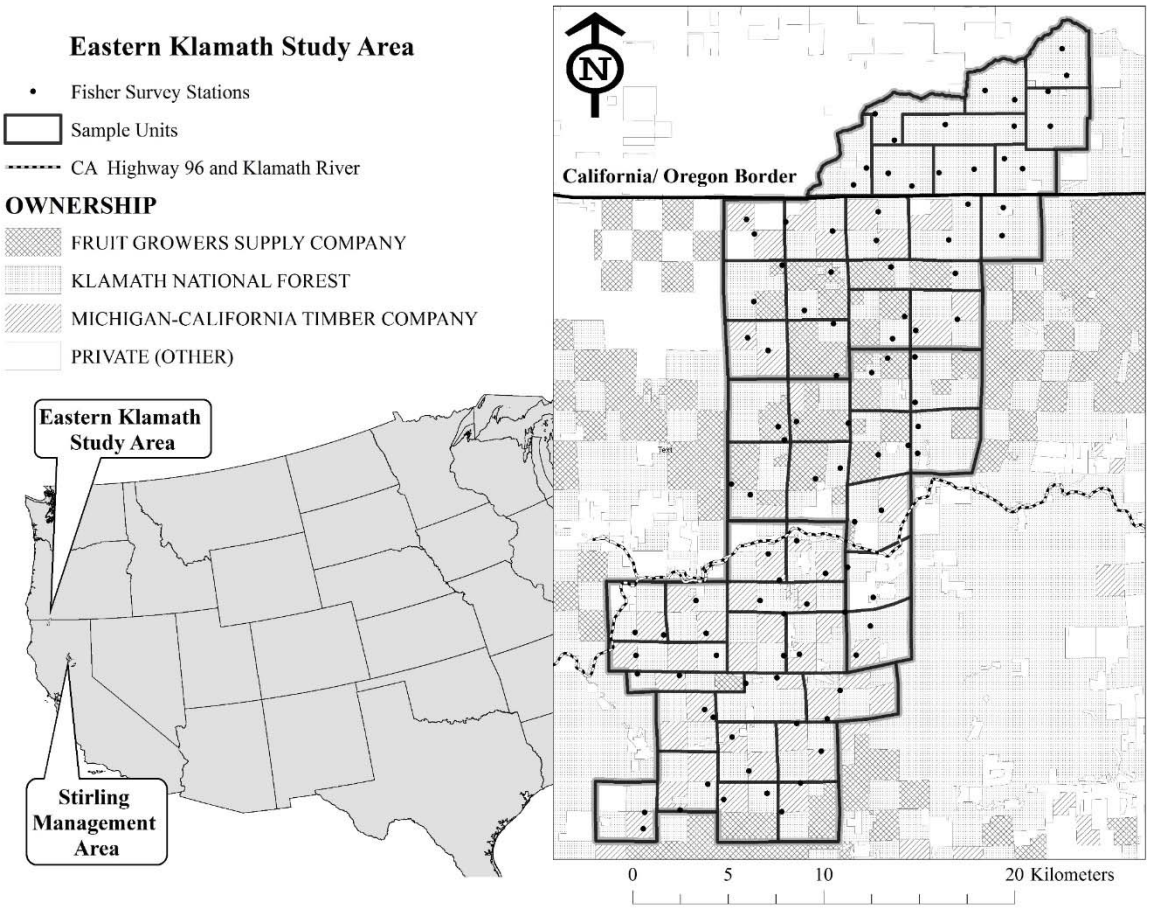


Figure 2. Release locations for all fishers at the beginnings of year-1 (2009-2010), year-2 (2010-2011), and year-3 (2011-2012) of the translocation to the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California.

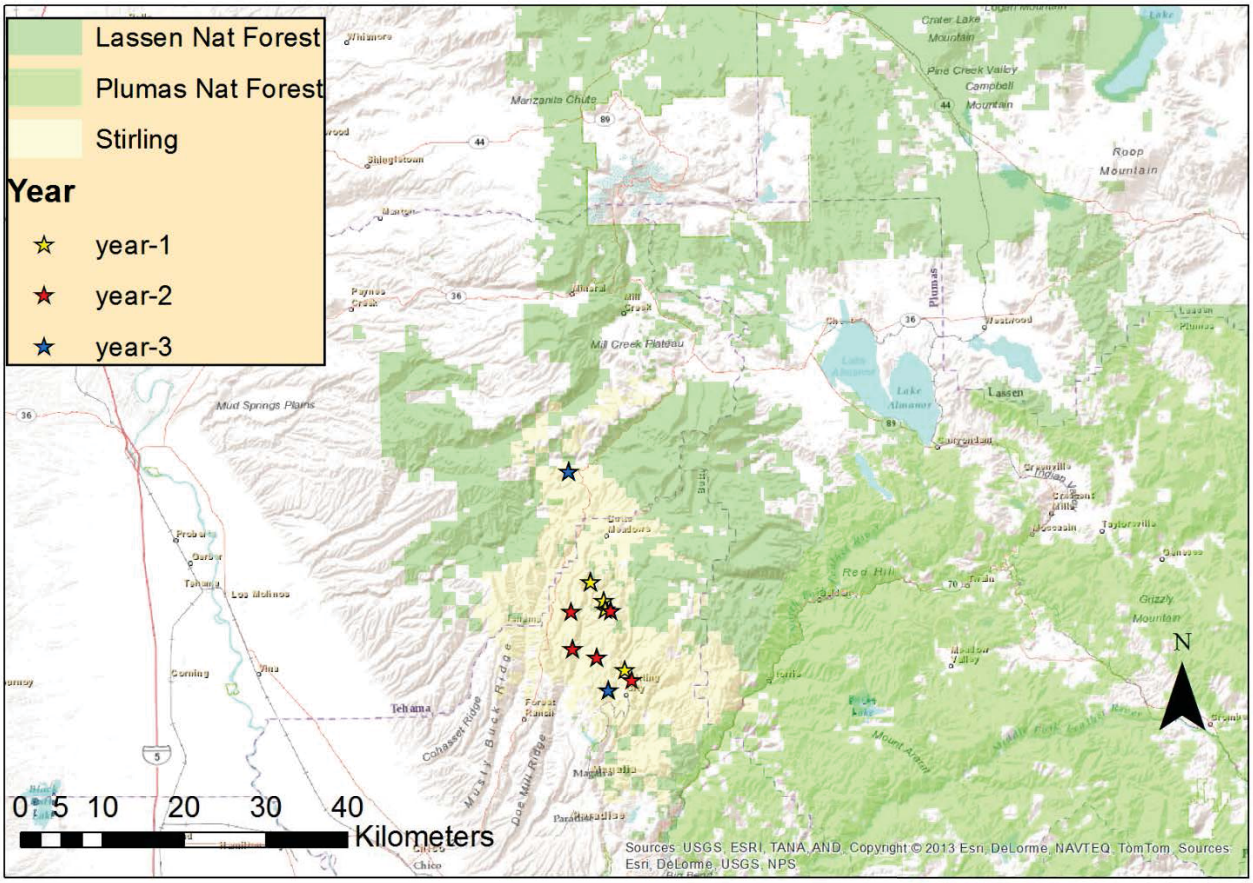
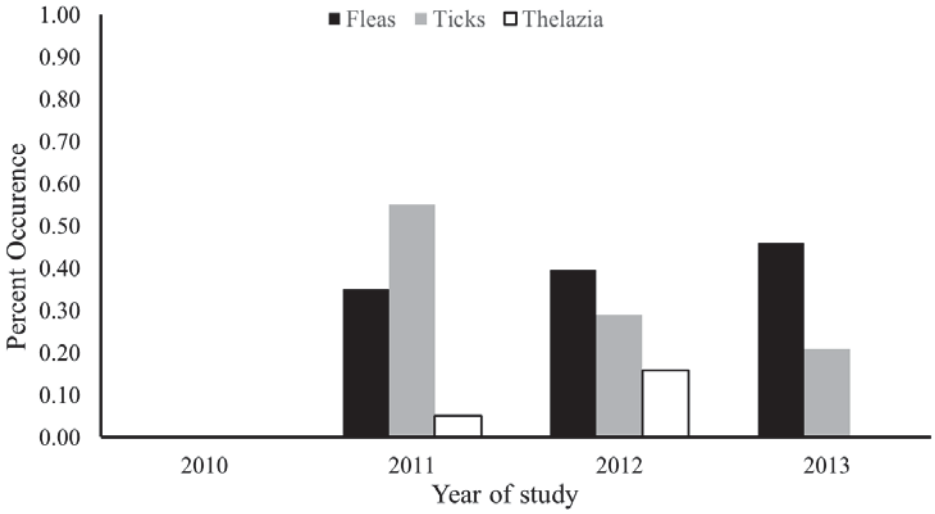
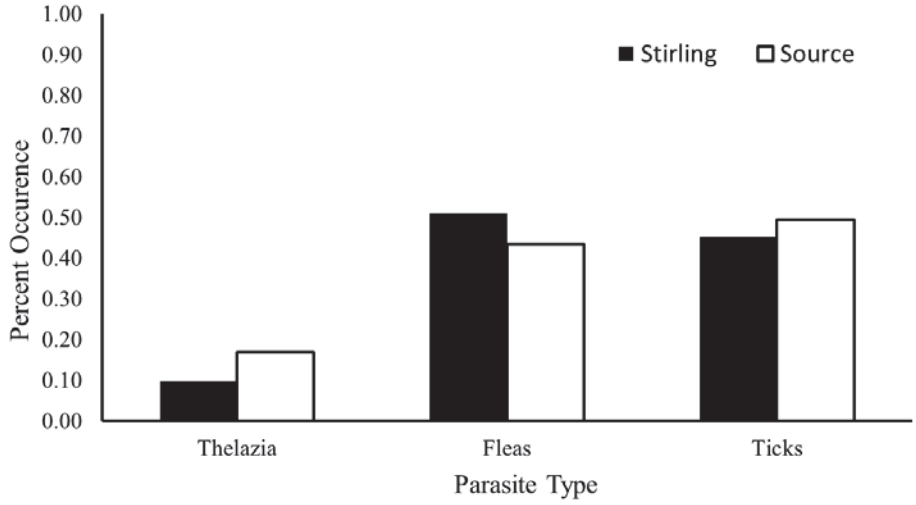


Figure 3. Percent occurrence of 3 types of ecto-parasites found on fishers on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California. The upper figure shows the occurrence of parasites on Stirling by year. Occurrence of ectoparasites in 2010 was based on a single male fisher released in January and recaptured in December. The figure compares the occurrence of parasites on fishers on Stirling compared to fishers in the source populations for the reintroduction. The lower figures shows the percent of captured animals that had at least one type of ecto-parasite from data collected throughout northern California in 2009-2011 (including the Stirling reintroduction site) and just from Stirling in 2012-2013.





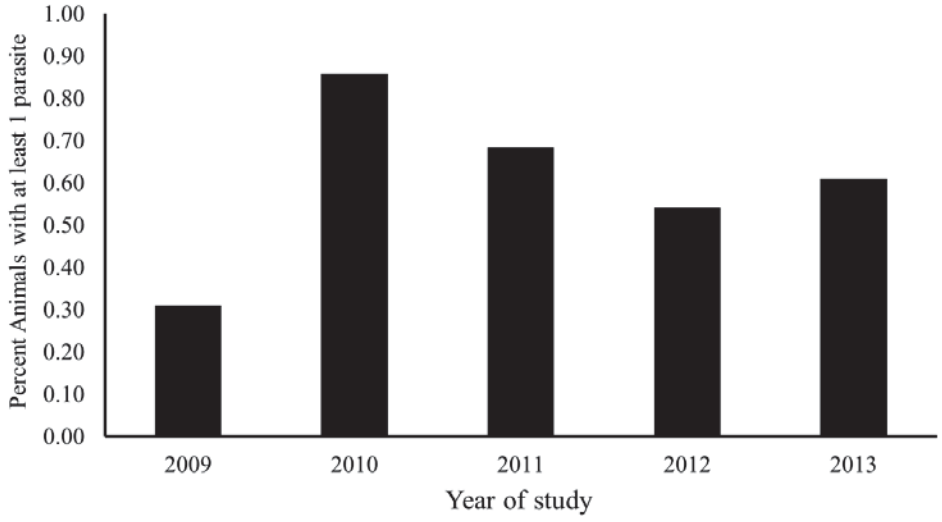


Figure 4. Percent of estimated locations of fishers obtained via Argos, GPS and VHF telemetry at different times of day across all years of study (2009-2013) on the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California.

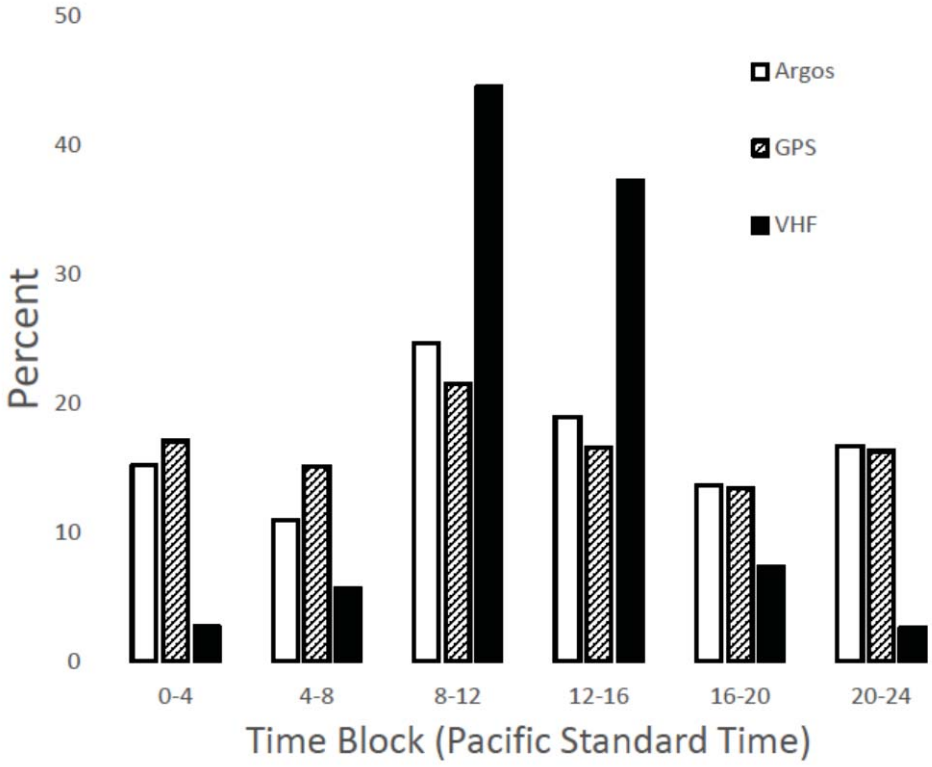


Figure 5. Home ranges (95% fixed kernel) of female fishers in 2013 calculated with h = 750 m.

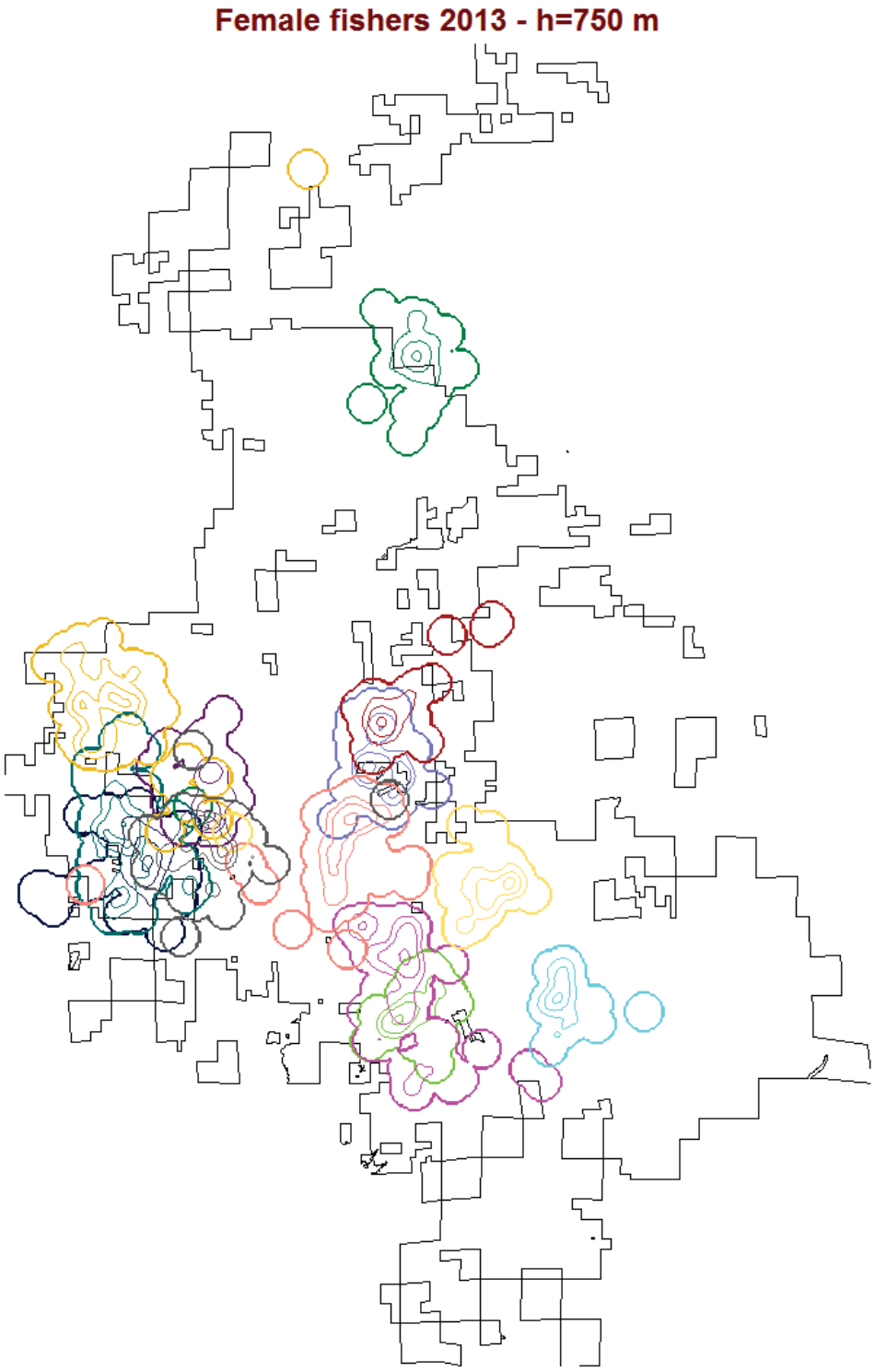


Figure 6. Home ranges (95% fixed kernel) of female fishers in 2013 calculated with h = 1500 m

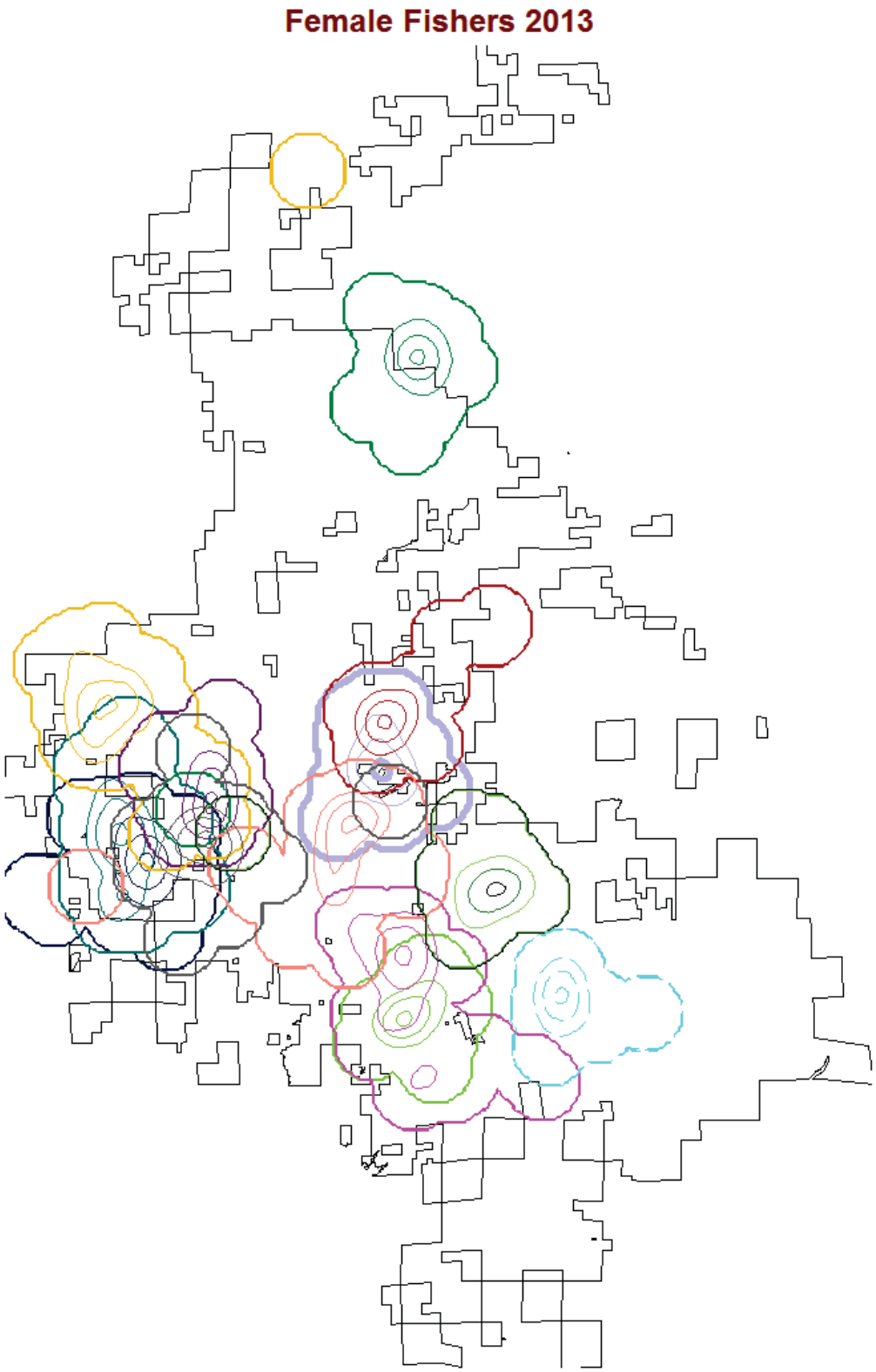


Figure 7. (Top panel) Locations of VHF telemetry azimuths (red dots) and known locations (den trees, trap locations, and rest locations; green dots) for female and VHF tracked male fishers from 2009-2012, and (Bottom panel) Location class 1, 2, and 3 Argos location estimates (blue dots) for male fishers from 2009-2012. For both panels most dots intersect with the Stirling tract (place of release for all translocated fishers) located in the northern Sierra Nevada and southern Cascade mounts of northern California.

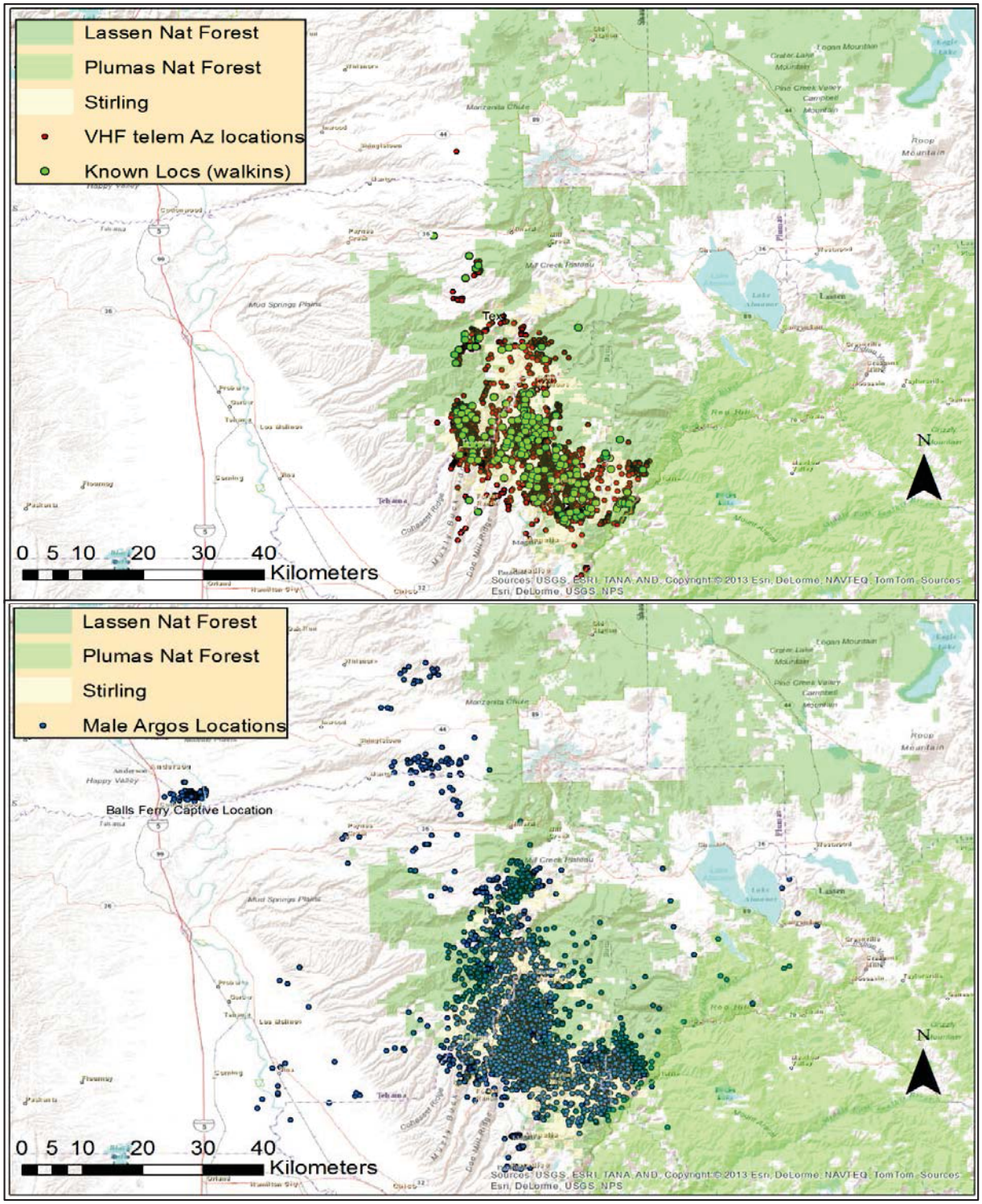


Figure 8. Percent of fishers by age distribution based off cementum annuli estimates (animals captured in 2013 are estimates based on body size, and development; n = 7) on Stirling in northern California.

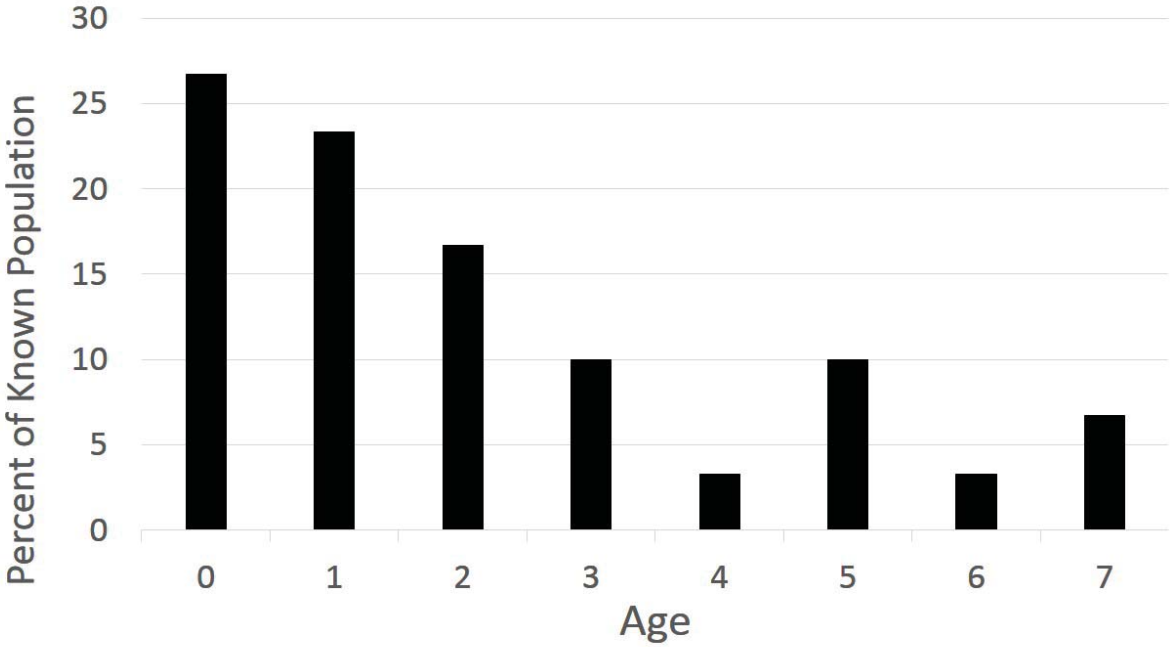


Figure 9. Reintroduced fisher populations can take any of 3 trajectories after releases of fishers are finished, highlighting the importance of following populations closely in the years after releases are finished. Facka et al. (in preparation) have simulated the dynamics of reintroduced fisher populations counting female fishers only. They simulated reintroductions of fishers for which 9, 30 or 60 females were released in equal numbers in each of 3 years, and for which growth rates for reintroduced populations were negative, zero, or positive after the final release (year 3). They simulated early releases of females (solid line), which did not reduce denning rates, and simulated late releases with a 34% reduction in denning rate (dashed lines), a 66% reduction in denning rate (dotted lines), and a 90% reduction in initial denning rate (long-dashed line) in the year following translocation.

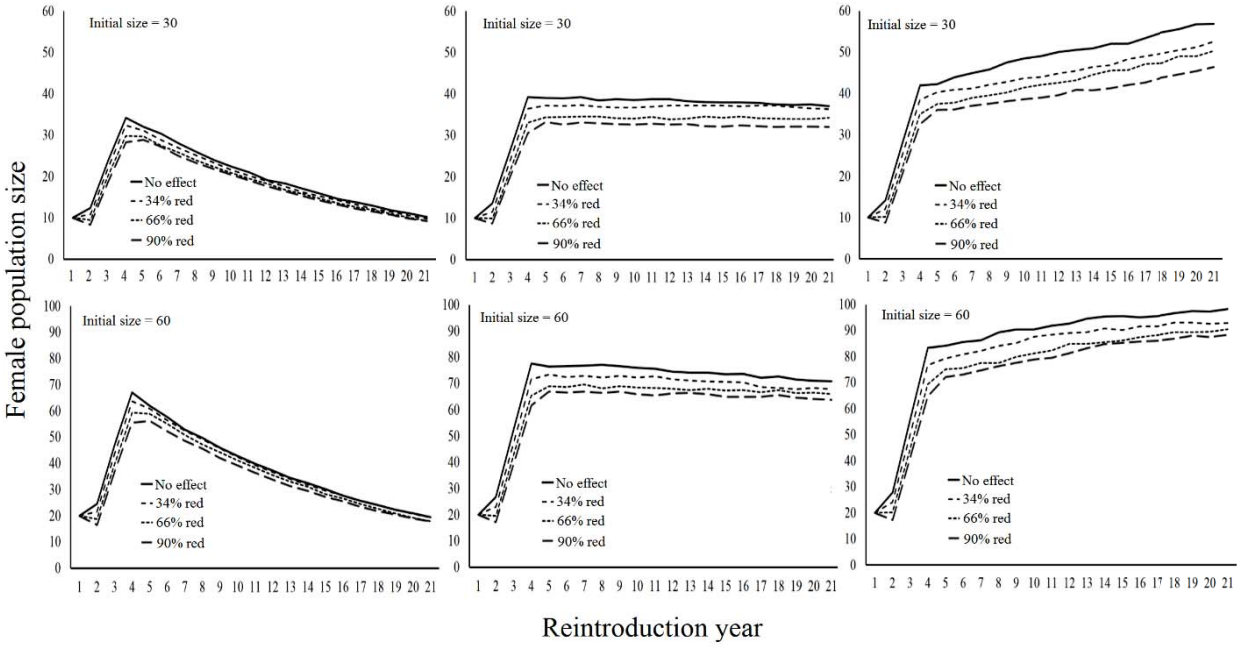


Figure 10. Locations of fishers' dens identified during 2010, 2011, and 2012 on, or near, the Stirling Management Area of Sierra Pacific Industries in the Northern Sierra Nevada and Southern Cascade Mountains of northern California.

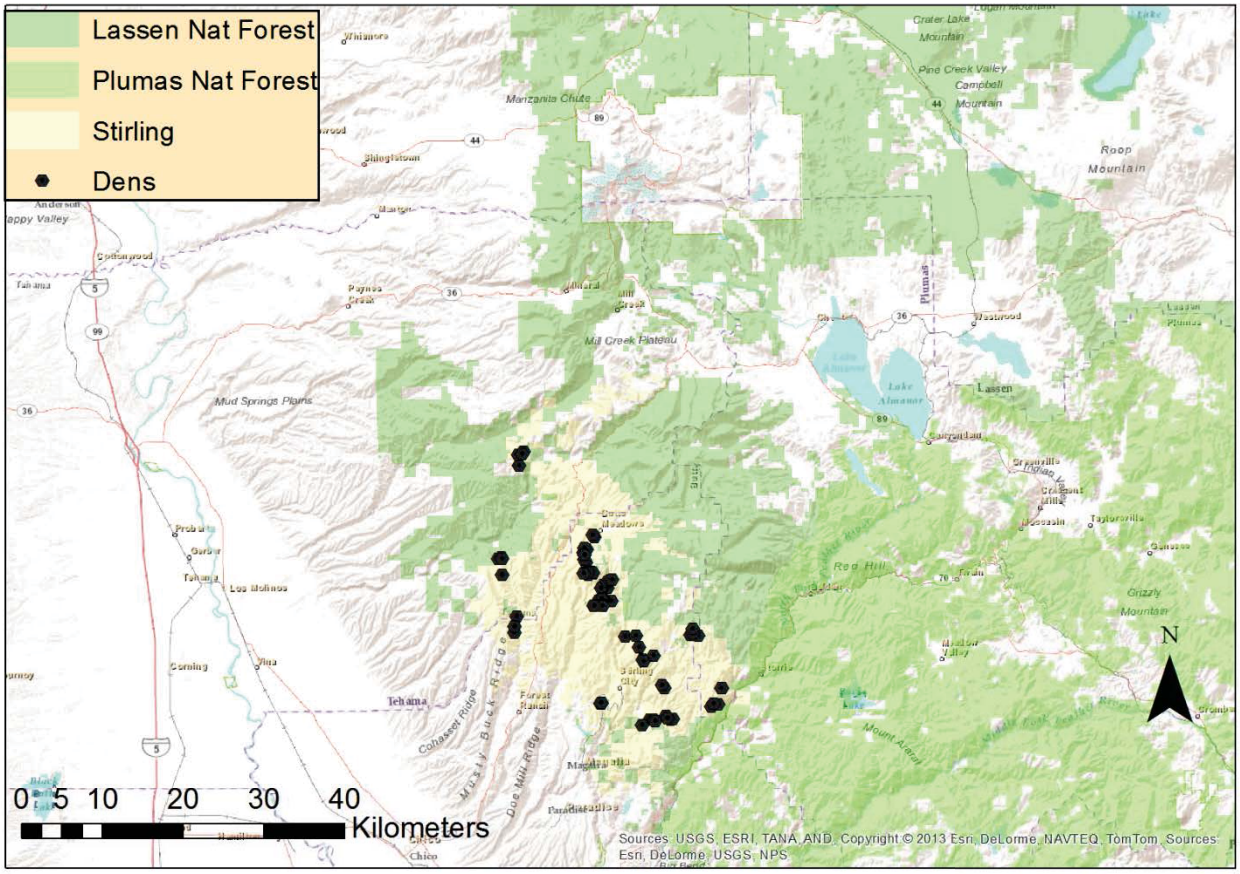


Figure 11. Coroplast tunnel used to collect samples of fisher hairs with follicles attached. Fishers that enter a tunnel and leave a hair sample can be identified by their individual DNA. Each tunnel was 25x25x75 cm (10x10x30 in) with a hardware cloth back to prevent entry or exit through the rear and with 3 2x4 cm (1x2") boards in the front, starting 10 cm from the bottom of the front of the tunnel. The bottom board had a strip of non-poisonous glueboard attached underneath. Each tunnel was baited with a can of moist cat food and a piece of raw chicken. An animal wishing to enter the tunnel to reach the bait was forced to crawl under the bottom board and the glue strip captured hair. We installed track plates in half of the stations in 2007-2008 and in all stations in 2009-2011 and used the track plates to help identify station visitors. This tunnel has a track plate.

Figure 12. Map of the Stirling management area showing the units of the 2013 non-invasive monitoring pilot, the suggested expansion for 2014, and relation to major roads.