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STATUS OF FISHERS IN GLACIER NATIONAL PARK, MONTANA

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ABSTRACT—Fishers (*Pekania pennanti*) are a mid-sized forest-dwelling carnivore in the family Mustelidae, once widely distributed across the northern US and Canada. Between 1800 and 1940, they were extirpated across much of their former range through commercial fur harvesting and habitat modification. Glacier National Park (GNP), which maintains a wildlife sighting database containing public and agency sighting and track records of Fishers from 1947 through the present, presumed Fishers extant in the park. Over 2007–2012, GNP made opportunistic efforts to collect Fisher DNA in hair traps but were unsuccessful. In 2013 and 2015, GNP conducted a more intensive effort to document the occurrence of Fishers by systematically placing baited hair traps within putative Fisher habitat across the park. These efforts were also unsuccessful and I show through application of Bayes' Theorem that a resident population of Fishers in GNP is highly improbable. Past credible sightings of Fishers in GNP were probably animals dispersing from occupied habitats to the west of GNP, and I suggest that regular occurrence of deep, unconsolidated winter snow may have prevented Fishers from occupying GNP in the past.

Key words: Bayes' Theorem, DNA, Fisher, Glacier National Park, Montana, *Pekania pennanti*

The Fisher (*Pekania pennanti*) is a mid-sized forest-dwelling carnivore in the weasel family (Mustelidae). Once widely distributed across the northern US and Canada, largely unregulated commercial fur trapping and habitat alteration from timber harvest resulted in greatly diminished populations. Between 1800 and 1940, they were extirpated across much of their former range (Allen 1942). Although Fishers were believed to occur in Glacier National Park (GNP) historically (Bailey and Bailey 1918), they may have been extirpated from the Rocky Mountains by the mid-1900s (Weckwerth and Wright 1968). During the late 1950s and early 1960s, the Montana and Idaho Fish and Game Departments implemented several re-introductions in the Swan, Pintler, and Bitterroot-Selway mountain ranges in Montana (Weckwerth and Wright 1968), and in the Purcell Mountains and Frank Church-River of No Return Wilderness in Idaho (Williams 1962). In the late 1980s and early 1990s, additional Fishers were translocated into the Cabinet Mountains of Montana (Roy 1991), of which the eastern edge is approximately 100 km west of GNP (within the dispersal capabilities of Fishers; Roy 1991; Proulx and others 1994). The reintroductions appear to have been successful as these areas currently support Fisher populations (Powell and Zielinski 1994;

Vinkey 2003). Reintroductions comprised Fishers captured in British Columbia, Minnesota, and Wisconsin.

Genetic research revealed that Fishers were not extirpated from Montana prior to these reintroductions because investigators found a native Montana-Idaho genetic signature that could not be attributed to any of the populations used for translocations (Vinkey 2003; Schwartz 2007). Follow-up work suggested that native Fishers were present in the Lochsa River drainage and Selkirk Mountains of Idaho. However, in locations with the native Montana-Idaho haplotypes, non-native haplotypes known from the areas used for the reintroductions were also present (Vinkey and others 2006). We hypothesized that if a purely native population still existed in the northern Rocky Mountains, it would be in GNP where trapping and timber harvest have been prohibited since 1910.

A GNP database of wildlife observations reported by visitors and staff contains 196 unconfirmed sightings of Fishers or their tracks dating back to 1947. During the early 1990s, concern over the status of Canada Lynx (*Lynx canadensis*), Wolverine (*Gulo gulo*), and Fisher populations across the region (Ruggiero and others 1994) prompted resource management

agencies, including GNP, to conduct winter track surveys for these species. Mustelid tracks measuring >5 cm in length with a bounding stride >81 cm were considered to be those of Fisher. During 1994, GNP staff encountered putative Fisher tracks at 7 sites during 35 km of surveying. A private consulting firm conducted more intensive winter track surveys, 1999–2004, and detected putative Fisher tracks 83 times over 3165 km surveyed (GNP, unpubl. reports).

Prior to 2005, GNP considered track surveys a useful method for detecting Fisher presence and estimating relative density, but problems with track identification and high snowfall reducing survey opportunities led to the adoption of non-invasive genetic sampling methods for detecting Fisher presence in GNP. One such method entails luring Fishers and other mid-size carnivores into a baited box containing devices (gun brushes or glue strips) that passively capture hair while the animal is inspecting the bait (Zielinski and others 2007). In a genetics lab, DNA is then extracted from the hair and used to identify the species (Riddle and others 2003), determine if the individual is a native to the sample region, or descended from a particular reintroduction. When combined with probability sampling designs, estimates of distribution and abundance are also possible.

In January 2007, GNP and US Forest Service-Rocky Mountain Research Station (USFS-RMRS) staff initiated a pilot study in western GNP using the hair-trap method described above. Twelve traps were deployed approximately 1 km apart along a 13-km transect, between park headquarters and Sprague Creek. The traps were checked twice at approximately 3-wk intervals, resulting in 19 hair samples that were analyzed at the USFS-RMRS genetics laboratory in Missoula, Montana using mustelid-specific control region primers. Eighteen samples were identifiable to species, but none were from Fishers or other mustelids. In 2008 and 2009, 18 hair traps were deployed approximately 1 km apart from Sprague Creek to Logan Creek. Also in 2009, we deployed 6 traps along the inside North Fork road from Ford Creek to Kintla Lake. Again, no Fishers were detected. In 2010, survey efforts were moved to the east side of the park where we deployed 20 traps in the upper St. Mary River, Waterton River, and Olson Creek drainages. No Fishers

were detected. In addition, over 2003–2008, researchers used log box traps to capture Wolverines in GNP. These traps often captured non-target species, including American Martens (*Martes americana*), Canada Lynx, and Red Foxes (*Vulpes vulpes*), but no Fishers were captured. From 2009–2012, GNP monitored Wolverines using baited hair-traps distributed systematically throughout GNP (Waller, in review). Again, diverse non-target species were detected, but no Fishers. Lastly, no records exist of Fishers being killed on park roads even though roads have been a common source of Fisher mortality in other regions (Koen and others 2007; Gabriel and others 2015; Sweitzer and others 2015). Consequently, by 2012, park biologists began to question whether Fishers were present in GNP. An effort of 400–500 trap-nights per year for over 4 y should have been sufficient to detect Fishers, even at low densities (Weir and Corbould 2006).

Three possible explanations exist for our failure to detect Fishers in GNP: (1) survey effort was insufficient; (2) the GNP Fisher population had recently been extirpated; or (3) GNP never had a population of Fishers and previous observations were either misidentifications or reintroduced Fishers (or their progeny) passing through the park. This report focuses on efforts to eliminate the first possibility by implementing an intensive sampling program throughout potential Fisher habitat in GNP.

METHODS

We first identified areas in GNP most likely to have Fishers (essentially old-growth forests near lakes and streams) using a habitat suitability model (Allen 1983). Using a geographic information system, we overlaid a 4-km × 4-km grid over these areas and deployed 1 hair trap per grid cell (Fig. 1). To lure Fishers to hair traps, we nailed approximately 1 kg of deer or chicken meat to the trunk of a tree about 2 m above the ground. The meat was wrapped in chicken wire to discourage scavengers and increase its longevity. The bait was covered with a corrugated plastic board to funnel Fishers to the hair trap (Fig. 2). We also used Caven GustoTM lure (Minnesota Trapline Products, Pennock, MN) smeared on the bait tree to increase the stations attractiveness. We placed four 7.62 mm diameter phosphor-bronze gun

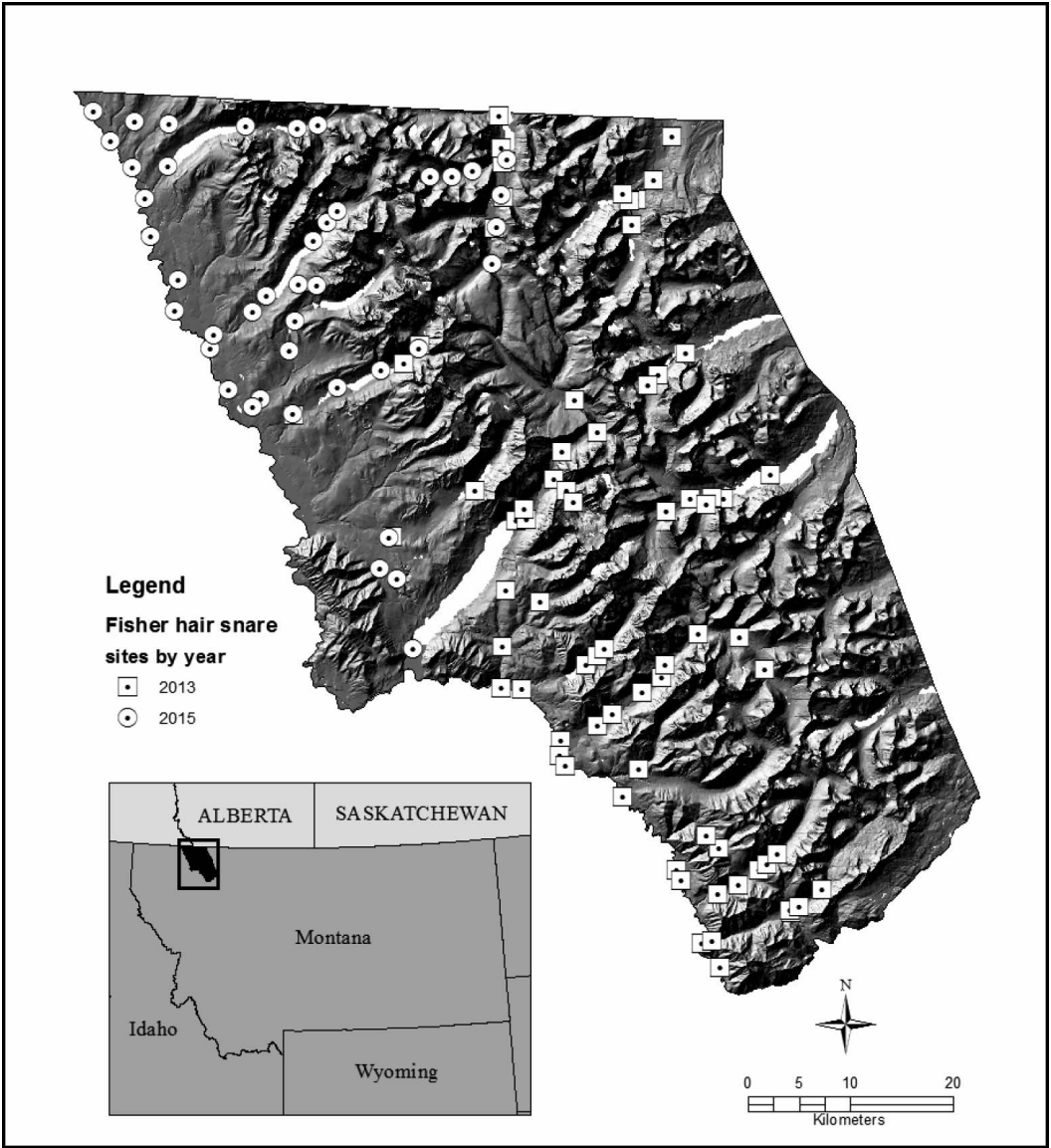


FIGURE 1. Distribution of Fisher hair-trap sites deployed in Glacier National Park, Montana, during winters 2012-2013 and 2014-2015.

brushes below the bait to snag hair from any animal that might investigate the bait (Fig. 2). A team of volunteers and GNP employees set up the hair traps and checked them every 2–3 wk from December through March each winter. During 2012–2013, each site was checked 3 times, and during 2014–2015, each site was checked 4 times. During 2013, we sampled

primarily in the southern and eastern portions of the park (Table 1, Fig. 1), and during 2015, we primarily sampled in the western and northern portions of the park (Table 1, Fig. 1). We also deployed 10 Bushnell Trophy Cam™ remote cameras (Bushnell Outdoor Products, Overland Park, KS) to monitor bait stations for Fisher activity. Cameras were distributed 1



FIGURE 2. An American Marten inspects a Fisher hair trap in Glacier National Park, Montana, in 2013. The bait is placed under the plastic cone (labeled LOG/PAC #3) in chicken wire, and hair is collected on gun brushes mounted below the plastic cone.

TABLE 1. Hair-trapping effort in Glacier National Park, Montana, winter 2012-2013 and winter 2014-2015.

Drainage	Number of sites (Number of visits to each site)	Setup – Takedown (Number of days)	Trap nights
2012-2013			
McDonald Creek	9 (3)	12/30 – 03/27 (88)	704
Nyack Creek	9 (3)	12/29 – 02/28 (61)	610
St. Mary River	6 (3)	01/11 – 04/03 (82)	492
Belly River	6 (3)	01/16 – 03/19 (62)	372
Waterton River	6 (1)	01/19 – 04/01 (72)	432
Many Glacier	3 (3)	01/04 – 03/13 (68)	204
Harrison Creek	4 (3)	01/19 – 03/26 (66)	264
Park Creek	5 (3)	01/09 – 03/16 (68)	340
Camas Creek	2 (3)	01/19 – 02/14 (26)	52
Lincoln Creek	4 (2)	01/19 – 03/17 (75)	300
Ole Creek	6 (4)	01/23 – 03/28 (64)	384
Pinchot Creek	1 (2)	02/04 – 03/09 (33)	33
Middle Fork Flathead River	7 (3)	01/05 – 04/01 (86)	602
Muir Creek	2 (3)	01/05 – 04/01 (86)	172
Logging Creek	3 (2)	02/10 – 03/28 (76)	228
Totals:	73	5189	
2014-2015			
Akokala Creek	4 (4)	01/24 – 03/30 (65)	260
Bowman Lake	4 (4)	01/16 – 03/27 (70)	280
Camas Creek	4 (4)	12/23 – 03/08 (75)	300
Cerulean Lake	5 (4)	01/18 – 03/20 (61)	305
Kintla Lake	6 (4)	01/10 – 03/25 (74)	444
Kishenehn Creek	5 (4)	01/15 – 03/14 (58)	290
Logging Lake	5 (4)	01/17 – 04/04 (77)	385
Quartz Creek	3 (2)	01/25 – 03/30 (64)	192
Waterton River	7 (2)	01/27 – 03/28 (60)	420
Totals:	43	2876	

camera per trap line, and moved systematically from bait station to bait station every 2–3 wk.

During site checks, baits were replenished as needed and gun brushes with hair were collected and replaced with new brushes. Gun brushes with snagged hair were placed in vials containing silica desiccant, labeled, and sent to the USFS-RMRS National Genomics Laboratory in Missoula, Montana for genetic analyses. At the laboratory, hair samples were removed from the gun brushes and whole genomic DNA was extracted using the QIAGEN Dneasy Tissue Kit (Qiagen, Valencia, CA) with modifications for hair samples (Mills and others 2000). The laboratory identified species by using the control region of mitochondrial DNA amplified using universal primers (Kocher and others 1989), and comparing DNA sequence data to species databases at the RMRS and National Center for Biotechnology Information Genbank (Benson and others 2013).

Use of sighting reports or other anecdotal data to establish species presence or absence is inherently unreliable (McKelvey and others 2008), and I recognize their limitations. However, in order to account for the probability that our data contained false negatives, I constructed a prior distribution of putative Fisher occurrences by overlaying the 196 Fisher sightings, collected 1947–2013, onto our sampling grid and calculated the proportion of cells with observations. Although the probability of detecting Fishers in hair traps like ours when they are present is unknown, I assumed a detection probability of 50%, based on known detection probabilities for similar techniques (Slauson and others 2009).

If we let p' be the prior probability that a Fisher, if present, will be detected in a single survey at a single site, then the likelihood of a single non-detection is $1-p'$. If Ψ' is the prior probability that a Fisher occupies the site, then Bayes' Theorem (Wintle and others 2012) estimates the posterior probability of the site being occupied (Ψ) if it was not detected in a single survey:

$$\Psi = \frac{\Psi'(1-p')}{\Psi'(1-p') + (1-\Psi')} \quad (1)$$

The posterior probability of absence is $1-\Psi$. If Fishers were not detected during n sequential surveys of a site, then Bayes' Theorem shows

that the likelihood of obtaining a sequence of non-detections in an occupied site is $(1-p')^n$. The posterior probability that the site is occupied (Wintle and others 2005) is then:

$$\Psi = \frac{\Psi'(1-p')^n}{\Psi'(1-p')^n + (1-\Psi')} \quad (2)$$

For simplicity, we assumed that the probability of detection did not differ between sites or between visits (that is, detection probability remained constant over the course of the study), and Fishers were detected without error (that is, there were no false positives). We also assumed that sightings were independent.

Following Wintle and others (2012), we rearranged equation (2) to calculate the number of sequential non-detections (n^*) required to reduce Ψ to 10%, 5%, and 1% given Ψ' and p' :

$$n^* = > \frac{\log(\frac{\Psi}{1-\Psi}) - \log(\frac{\Psi'}{1-\Psi'})}{\log(1-p')} \quad (3)$$

We also estimated the posterior probability of detection using a flat beta-binomial prior with the observed data using 5000 iterations of a Markov Chain Monte Carlo (MCMC) simulation in the computer program Winbugs version 1.4.3 (Lunn and others 2000). The first 1000 runs were used as burn-in. Similarly, we used 50,000 iterations of a Winbugs MCMC simulation to estimate the posterior probability of occupancy (Ψ) with the observed data, using a beta-binomial prior for the probability of detection and a uniform (0,1) distribution for Ψ , with the first 1000 runs used as burn-in.

RESULTS

In 2013, we deployed 73 hair traps in 15 drainages located primarily in southern and eastern GNP (Fig. 1). From these hair traps, we collected and analyzed 159 hair samples and 4 scat samples for species identification, of which 145 samples contained useful DNA (91%). Most of the samples (100) were from American Martens, 4 from Wolverines, 1 from a Bobcat (*Lynx rufus*), 1 from a Short-tailed Weasel (*Mustela erminea*), and 39 samples were deer (*Odocoileus* spp.), likely from the bait in the hair traps. We deployed remote cameras at 25 sites for at least 1 session. No Fishers were detected using either technique.

In 2015, we deployed 43 hair traps in 9 drainages located primarily in the northwestern portion of GNP (Fig. 1). We collected 118 hair samples and 1 scat sample, of which 93 (79%) contained useful DNA. Most samples (69) were American Martens, 2 were Short-tailed Weasels, 1 was Striped Skunk (*Mephitis mephitis*), 3 were American Mink (*Neovison vison*), and 18 were deer, also likely from the bait in the hair traps. We deployed remote cameras at 19 sites during at least 1 session. Again, no Fishers were detected using either technique.

The mean posterior probability of occupancy among the 73 sites sampled in 2013 was 0.083 (range = 0.058–0.110). The mean posterior probability of occupancy among the 43 sites sampled in 2015 was 0.057 (range = 0.030–0.198). Based on equation 3, we would have reduced Ψ to 5% at 3.2 visits per site, and 10% at 2.1 visits per site. During 2013 we averaged 2.6 visits per site, and during 2015 we averaged 3.4 visits per site; thus, we exceeded 90% probability of absence in 2013 and 95% probability of absence in 2015. Achieving 99% probability of absence would have required 6 visits per site, a doubling of our 2015 effort.

Our MCMC simulation estimated a mean probability of detection of 0.002 (95% credible interval: 0.0002–0.026), given a flat beta (1,1) prior and a binomial distribution of our observed results (0 detections in 340 site visits during 2013 and 2015). Our MCMC simulation estimated a mean posterior probability of occupancy of 0.109 (95% credible interval 0.000–0.761).

DISCUSSION

Our effort to detect Fishers in GNP serves as a cautionary tale and underscores the concerns of McKelvey and others (2008) regarding the need for evidentiary standards for occurrence records. Most Fisher sightings in our database appear to be mistaken identifications of similar species, such as American Marten and American Mink. However, sightings by experienced field personnel are difficult to discount, and confirmed occurrences of Fishers exist just outside of the GNP boundary. Our database of Fisher sightings was assumed to be a reasonably reliable indication of Fisher presence, and has been used in the past to make conservation decisions in the park.

Despite our unsuccessful decade-long effort to document Fisher presence, we still receive unconfirmed Fisher sightings from the public and GNP staff. This recurring belief that Fishers inhabit GNP was the motivation behind our attempt to use a statistical approach to underscore our confidence that this species is absent. Absence, in this context, is a probabilistic function of survey effort, and we have demonstrated, through our substantial survey effort, that it is highly unlikely that Fishers are part of the resident fauna in GNP. We created an informative prior based on our sighting database because it seemed a reasonable approach to the problem, and is conservative in that we did not remove sightings for which we had less confidence, and because we assumed no misidentifications. The likelihood of detecting Fishers declined significantly with the use of an uninformative prior (the flat beta-binomial distribution) to a level very close to zero. Intuitively, 340 draws from a binomial distribution that produces no 1s, implies that no 1s exist.

If Fishers are indeed absent from GNP, how do we account for the credible sightings in our database? And, if they were present historically, what happened to them? In my view, the most likely explanation is that Fishers were never resident in the park and that the credible sightings (those sightings by experienced field biologists known to the author to have previous experience with Fishers), were of reintroduced Fishers or their progeny dispersing through the park (GNP is within dispersal distance of extant Fisher populations). Fishers are poorly adapted to areas that regularly receive deep, unconsolidated snows like GNP (Raine 1983). Although GNP contains areas that may be good Fisher habitat during warm, wet winters when snowfall consolidates, they are relatively small and isolated, and may not be suitable during cold, wet winters when the snow remains unconsolidated. Therefore, historically, GNP may never have had a resident Fisher population. The only historical record of Fishers in GNP was a questionable third-hand account (see Bailey and Bailey 1918). Furthermore, no historical records of Fisher exist for Waterton Lakes National Park, which is contiguous with GNP on the Canadian side of the border (Soper 1973). Alternatively, Fishers could have been extirpated by trapping prior to the establishment of GNP in 1910. However, other commonly

trapped species including the American Marten, Beaver (*Castor canadensis*), Wolverine, Canada Lynx, Bobcat, and Short-tailed Weasel all remain extant within GNP. It is also possible that Fishers were present historically, but some unknown ecological perturbation such as fire, predation, or disease caused their disappearance. However, the latter 2 hypotheses lack any empirical support; thus, the most parsimonious explanation of our findings is that GNP does not support a resident population of Fishers, currently or historically.

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