Original Research

Fisher (*Pekania pennanti*) distribution in riparian forest patches of northeastern North Dakota: habitat plasticity or a short-term aberration?

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Abstract

Fishers (*Pekania pennanti*) are a forest carnivore that was widely distributed throughout Canada and the northern United States of America. However, their populations were greatly reduced during the 19th and 20th centuries following habitat loss and unregulated trapping. Studies that established fisher habitat associations with dense forest and undergrowth connected to old-growth forest were completed on these remnant populations, contributing to generalized habitat paradigms that are potentially biased because they are based on habitat conditions within the range occupied by the remnant populations and not the totality of conditions within the historic range of the fisher. More recently, fisher populations have begun expanding naturally and through reintroduction efforts. Although these populations persist within the historic range of the fisher, they often occupy habitats that do not appear to fit accepted habitat paradigms for the species (e.g., occurrence in deciduous and/or patchy forests). Our study focused on a fisher population in North Dakota (ND) occupying forested, riparian patches, and presumed to have initially colonized the northeastern region of the state since 1999. We summarized verified fisher sightings collected by the North Dakota Game and Fish Department from 1999 through 2019 to assess fisher distribution over time. During the summer of 2009, we used remote cameras placed in riparian-forest patches distributed throughout northeastern ND to compare aspects of size and spatial distribution among forested patches where fishers were and were not detected. Based on existing habitat paradigms, we hypothesized fishers occupying the area would occur most frequently in larger, more proximate forest patches of the riparian forest. However, neither forest patch size nor proximity contributed to explaining the patterns of fisher detections. Furthermore, we evaluated latency to detection (as the number of days

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until detection) and determined that fishers were detected quicker in small patches (1-50 ha) than medium (>50-250 ha) and large (>250 ha) forest patches, an outcome implying that fishers are more likely to encounter a camera in a small patch than larger patches leading to fewer days until detection. The lack of support for our hypothesis that fisher habitat associations would reflect historic paradigms provides evidence for fisher habitat plasticity and their potential ability to expand and persist in habitats not reflected by historic habitat paradigms.

Key Words: Fisher, Habitat Associations, Habitat Paradigms, Linear Forest, Mustelidae, Natural Recolonization, North Dakota, *Pekania pennanti.*

INTRODUCTION

Historically, fishers (*Pekania pennanti*) were widely distributed in forested areas throughout much of Canada and the northern and Midwestern United States of America (USA), with ranges extending southward along the Appalachian, Rocky, and Coastal Pacific mountain ranges (Hagmeier 1956; Douglas and Strickland 1987; Powell 1993; Gibilisco 1994; Williams *et al.* 1998), but many populations declined or became extirpated following extensive anthropogenic influences, primarily timber harvest and unregulated trapping, from the mid- to late-19th century through the mid-20th century. Extirpations were particularly severe in the southern extensions of the fisher range, with populations in the USA persisting primarily in remote and less disturbed forested portions of Minnesota, Maine, New York, and New Hampshire (Hagmeier 1956; Balser and Longley 1966; Brander and Books 1973; Douglas and Strickland 1987; Powell 1993). Initial studies of fishers thus occurred in relatively undisturbed forest in northern portions of their historic range where populations persisted (Coulter 1966; Kelly 1977; Powell 1977; Allen 1983), often in areas where remoteness likely buffered them from large-scale anthropogenic perturbations. Northern areas where fisher populations persisted in the eastern USA (and where many early studies of fishers were conducted) naturally comprise a higher proportion of coniferous forests than the southern portions of their historic range in the middle and southern Appalachian Mountains.

Understandably, early perceptions and paradigms that developed about fisher habitat requirements were based largely on early studies of remnant populations in the northeastern USA, which often occupied remote contiguous tracts of forest with canopy closure, dense undergrowth, coarse woody debris, conifers, and some connection to old growth forest (Coulter 1966; Kelly 1977; Powell 1977; Allen 1983). However, persistence of fishers in these areas may be as much attributable to factors related to remoteness and accessibility as to specific habitat conditions, and paradigms that became entrenched about fisher habitat requirements may not reflect the totality of habitat conditions that can sustain fisher populations. In fact, recent studies suggest fishers may exhibit greater plasticity in habitat associations than indicated by previous studies (Triska *et al.* 2011; Erb *et al.* 2016; Proulx 2017; Proulx *et al.* 2018).

Reintroduction projects and natural expansion of remnant populations have contributed to the recovery of some extirpated fisher populations (Douglas and Strickland 1987; Williams *et al.* 2006; Lewis 2013; Erb *et al.* 2016). For example, fishers are once again occurring in portions of the mid-Atlantic region of the eastern USA (e.g., populations developed through reintroductions in West Virginia and Pennsylvania; Pack *et al.* 1981) and populations recently established in western Minnesota (MN) and eastern North Dakota (ND) through natural recolonization (Erb 2008; Triska *et al.* 2011; Loughry *et al.* 2012). The reestablished populations in MN and ND were founded by individuals dispersing from a well-established population occupying predominantly coniferous forests in northeastern MN (Erb 2008; Triska *et al.* 2011). The natural expansion of fishers from the coniferous forest in northeastern MN into the prairie ecosystem of western MN and eastern ND suggests that fishers may exhibit greater habitat plasticity than once presumed (Erb 2008; Triska *et al.* 2011; Erb *et al.* 2016). Accordingly, the aforementioned examples highlight deviations from established habitat paradigms for fishers, with deciduous trees dominating forests at fisher reintroduction sites in Pennsylvania (Serfass *et al.* 1994) and western expansion of the population from northeastern MN occurring along fragmented forest patches of exclusively riparian forest comprised of deciduous trees (Hagen *et al.* 2005).

Fishers historically occupied portions of eastern ND but overtrapping presumably caused the extirpation of this population (and likewise for western MN) by the early 1900s (Bailey 1926; Adams 1961; Gibilisco 1994). The landscape of ND is unique among areas within the historic range of fishers in not being substantially forested in recent geological history. The landscape prior to European settlement was predominantly a prairie matrix (now mostly replaced by agriculture fields) with limited, patchy forests (<2% of the state was and currently is forested; Haugen *et al.* 2009). In the northeast, these forests are entirely deciduous

and primarily occur in riparian areas and a large escarpment (Bailey 1926; Hagen *et al.* 2005; Sovada and Seabloom 2005; Haugen *et al.* 2009). These prevailing conditions at a landscape-scale are strikingly inconsistent with paradigms of habitat conditions required for fishers.

Minnesota trapping records show that fishers began expanding westward along forested riparian corridors from northeastern MN during the 1990s (Erb 2008). In 1999, the first contemporary verified fisher report occurred in ND and the number of reports (e.g., visual observations, photos, carcasses) increased over the following years, prompting interest by the North Dakota Game and Fish Department (NDGF) to investigate the occurrence of fishers in the state. We examined all verified reports of fishers accumulated by NDGF since 1999 and used remote cameras to evaluate the spatial distribution of fishers in northeastern ND. Furthermore, we examined if remote camera detections were related to forest patch size and proximity. By evaluating fisher habitat associations in more detail, we aimed to determine if fishers were using habitats in ND in a similar way as indicated by habitat paradigms (e.g., preference for larger, contiguous forest) or if they utilize small and distant forest patches indicating greater habitat plasticity than has been described. Our primary intentions were to assess the distribution of fishers in northeastern ND, and we hypothesized that fishers would be most frequently detected in large, contiguous forest patches near other forest patches.

STUDY AREA

Our study covered approximately 15,500 km^2 in the northeast corner of ND, focusing on the riparian forests along the Goose, Pembina, Tongue, Turtle, and Red Rivers, and within the Pembina Hills, an escarpment containing portions of the Pembina and Tongue Rivers (Figure 1). Historically, the landscape in eastern ND was dominated by tallgrass prairie, with forested areas being limited to surrounding waterways and the Pembina Hills (Bailey 1926; Renard *et al.* 1986). Tall grass prairie was converted into agricultural fields during the 1800s, but portions of native forests persisted along waterways and throughout much of the Pembina Hills (Renard *et al.* 1986). Overall, native forests and grassland prairie in eastern ND now exist as various-sized forest patches interspersed within a landscape dominated by agricultural fields (Hagen *et al.* 2005; Haugen *et al.* 2009; the portion of the Red River in northeastern ND depicted in Figure 1 serves as an example of the patchy nature of riparian forests in our study area). Additionally, forest patches along the Pembina, Tongue, Turtle, Red and Goose Rivers and the Pembina Hills, had a mean forest patch size (± SE) of 4,084 ± 293 ha with a range of 0.05−34,180 ha

(Figure 1). The Pembina Hills represents the largest forest patch (34,180 ha) and contains portions of the Pembina and Tongue Rivers (i.e., where survey sites were located).

The forests now occupying eastern ND include lowland-deciduous riparian forests, upland-deciduous forests throughout the Pembina Hills escarpment, and planted shelterbelts (Hagen *et al.* 2005; Sovada and Seabloom 2005; Haugen *et al.* 2009). Riparian forests are dominated by American elm (*Ulmus americana*) and green ash (*Fraxinus pennsylvannica*), and box elders (*Acer negundo*) to a lesser degree (Hagen *et al.* 2005; Haugen *et al.* 2009). The escarpment in the Pembina Hills contains mainly bur oak (*Quercus macrocarpa*) with aspen (*Populus tremuloides*), paper birch (*Betula paperifera*) and box elder (*Acer negundo*), and green ash to a lesser degree (Hagen *et al.* 2005; Haugen *et al.* 2009). Shelterbelts were established in historically non-forested portions of the landscape to control erosion and contain predominantly non-native deciduous tree and shrub species and occasionally non-native conifer species (Johnson and Beck 1988; Kort 1988; Hagen *et al.* 2005; Sovada and Seabloom 2005).

MATERIAL & METHODS
Evidence of fisher recolonization

We obtained verified reports of fishers in ND comprising mortalities (i.e., carcasses of trapped, snared shot, and road-killed individuals), photographs and videos, and visual observations and accompanying information (e.g., date and county where the report occurred) collated by the NDGF from 1999−2019. Photographic and visual observations were assessed for validity based on the expert opinion of the NDGF furbearer biologists. Mortalities sometimes included information on age class and/or sex (74% and 96% of reports, respectively). Age class of fishers was determined via cementum annuli analysis completed on teeth extracted from carcasses (Matson's Laboratory, Manhattan, Montana, USA). We categorized and described fisher reports by type, number, and date of reports by county, and for age class and sex when applicable. We graphically portrayed the periods of the first report and numbers of reports obtained for fishers by county.

Remote camera trapping

We surveyed riparian forests, using remote cameras, to detect fishers in our study area during the summer of 2009 (see Triska *et al.* 2011 and Loughry *et al.* 2012). Remote camera types included Cuddeback® (Excite®, Expert®, and the infrared Noflash®; Non Typical Inc., Green Bay, Wisconsin, USA) and DLC Covert II® (DLC Trading Co. Llc, Lewisburg, Kentucky, USA). We collected data at remote camera locations (hereafter, 'survey sites') during
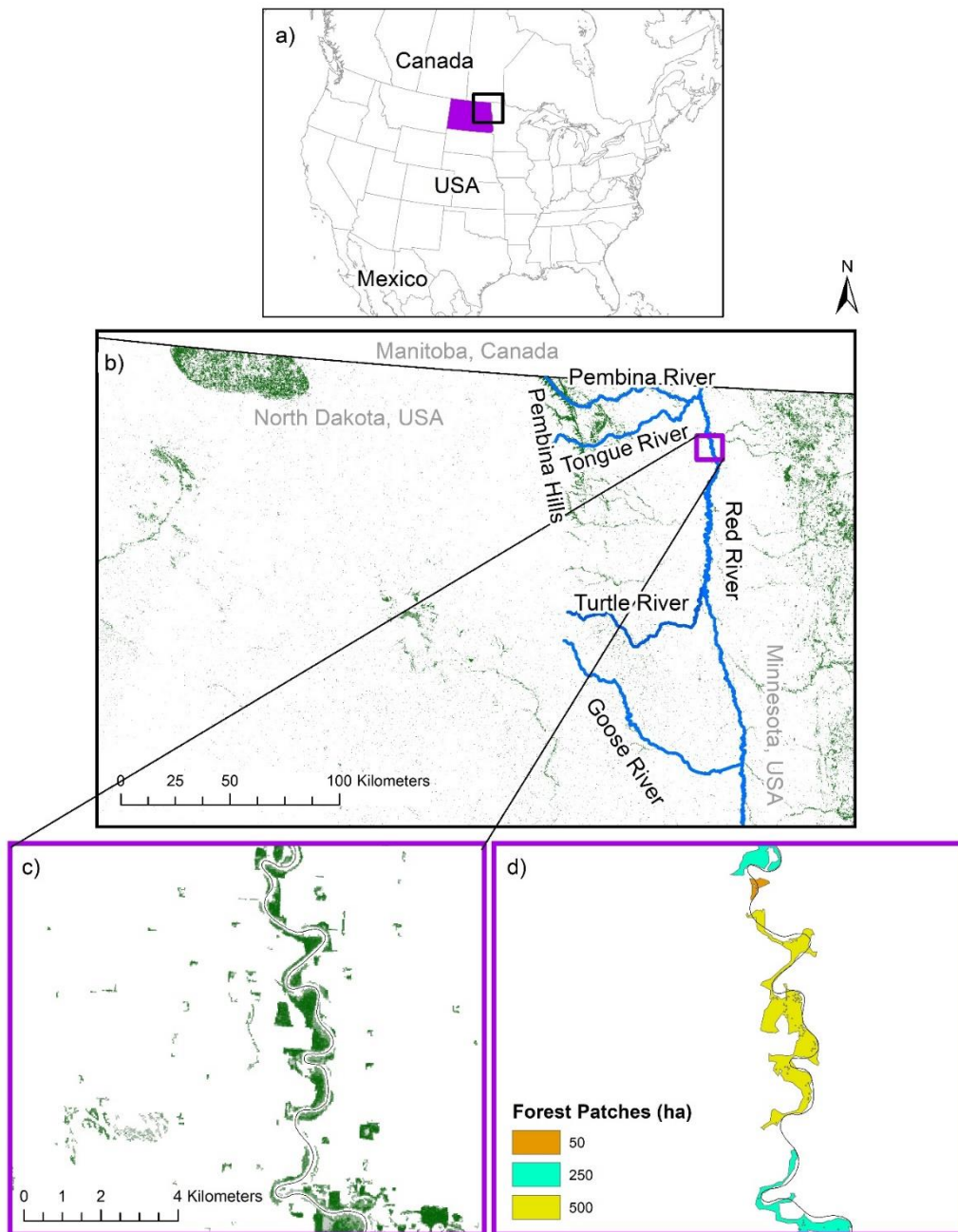
Figure 1. Location of the study area in northeastern North Dakota, where remote camera surveys were completed during the summer of 2009. The location of North Dakota within North America is highlighted in purple and the study area is outlined in black (a). The rivers surveyed within the study are identified by blue lines and the forest cover within the USA is shown in dark green with all white areas in the USA indicating they are not forested (b). The zoomed in area shown along the Red river, purple box, further displays how the forest is concentrated along the river (c) and how these forest patches were categorized for sampling (d). Forest patch categories are further defined in the Materials and Methods section. Note that sampling was focused on North Dakota, and therefore patches originating in Minnesota were not included as they were not available for sampling.

June, July, and August. Survey site locations were randomly selected within stratified forest patch sizes (small: 1-50 ha, medium: >50-250 ha, large: >250 ha) and both random survey site location and forest patch sizes were calculated in ArcMap (ESRI 2009). Exact survey site locations were influenced by land access, but we aimed to keep them as close to the random locations as possible. To calculate forest patch sizes, we defined 1-km buffers on both sides of rivers surveyed, except the Red River which only included the ND side, aggregated all forested patches within 250 m of the buffer and measured the forest patch size in hectares (Figure 1d). We surveyed forest patches throughout the drainage, and we monitored 143 survey sites over 4 cycles, with each cycle lasting for 13 days and including 25-44 survey sites. Each forest patch, other than the Pembina Hill contained only 1 survey site during each cycle.

At survey sites, we mounted remote cameras on a tree at a height of 0.5−1.5 m. We baited sites with ~85 g of American beaver (*Castor canadensis*) meat staked into the ground and a smear of American beaver castor mixed with ~2 g of glycerol placed directly on the ground 2−5 m in front of the cameras. Additionally, we hung a perforated film canister containing a cotton swab soaked in striped skunk (*Mephitis mephitis*) essence from a nearby tree branch at a height of ~2 m to serve as a general attractant. We checked and re-baited sites on day 7 – thus, each cycle contained 2 periods (set-up to re-bait and re-bait to removal). We described each unique picture or set of pictures as a detection, with the picture (or set of pictures) defined as unique when separated from the next picture by an elapsed time of ≥30 min. We considered the first 24-h survey period after set-up of a camera the first Detection Day (DD). Subsequent DDs were calculated with the next DD beginning after the previous DD completed 24-h of functioning properly. We omitted DDs for periods where a detection device was malfunctioning or was otherwise inoperable. We determined the Latency to Detection (LTD) among sites where detections occurred to be the number of DDs that accumulated until the first detection (Foresman and Pearson 1998).

Detection patterns

We used descriptive statistics to display fisher detections overall, by the 3 forest patch sizes (small, medium, and large), and proximity (measured as edge to edge to the nearest, adjacent forest patch). We discuss general detection patterns among major drainages in the study area. We used logistic regression specifically to assess if fisher detections differed by forest patch category and proximity. For our purposes, we considered only the full model and associated interactions, using $P<05$ as the significance level. An LTD cumulative density graph was used to provide insight on the number of

DDs typically required to detect a fisher for all occupied forest patches, and each forest patch category. Additionally, we completed Poisson regression to assess the influence of forest patch category and proximity on LTD. All analyses were conducted using base functions in program R (R Core Team 2020).

RESULTS

Evidence of fisher recolonization

From 1999− 2019, verified fisher reports collected by NDGF occurred in 27 of the 53 state counties with most occurring in the eastern counties that border MN (Figure 2). The first contemporary verified report of a fisher in ND occurred in Traill county (along the Red River, east-central ND) in 1999. Fisher reports increased substantially after 2011, which reflects the regulated trapping season for fishers initiated that year. The regulated trapping season occurred in roughly the eastern third of the state, starting in late November and lasting <1 week. A total of 618 fishers (241 males, 241 females, and 136 of unknown sex) were documented in eastern ND (Table 1). These reports included carcasses (n = 502), videos/photos (n = 84), visual observations (n = 25), incidental captures (n = 5) and sign (n = 2). Ages were determined for 375 of the fishers, with most (85% [318 of 375]) being ≤2 years of age The number of fishers in the sample by age class (in parenthesis) was 138 (0 −1), 117 (1−2), 63 (2−3), 24 (3−4), 16 (4−5), 9 (5−6), 4 (6−7), 1 (7−8), 1 (8−9), and 2 (9−10).

Remote camera trapping

We surveyed 143 sites for a total of 1,843 potential detection days. We removed 37 DDs among 8 cameras due to malfunction; all malfunctions occurred on or after day 7 of sampling. The average distance to the nearest small, medium, and large forest patch was 372 ± 38 m, 1,097 ± 149 m, and 1,061 ± 131 m, respectively. The mean forest patch size (± SE) surveyed was 2600 ± 690 ha. The mean proximity (i.e., distance to nearest forest patch of any size ± SE) was 274 ± 17 m with a range of 40−1,456 m.

Detection patterns

Fishers were detected at 77 of 143 survey sites (53.8%) over 150 d (Figure 3). Fishers were detected in all forest patch categories surveyed – small (27 of 51), medium (20 of 27), and large (30 of 65). In detected forest patches, the mean proximity ± Standard Error (95% Confidence Interval: CI) to the nearest forest patch was 270.7 ± 18.4 (CI 40.0 − 784.0 m), and 376.1 ± 30.0 (CI 102.0−763.0), 220.6 ± 20.1 (CI 40.0− 347.0), and 207.7 ± 26.9 (CI 42.0−784.0) to the nearest small, medium, and large forest patches, respectively. Detections were more common in the northern section of the study area and along the Red River, with fewer detections
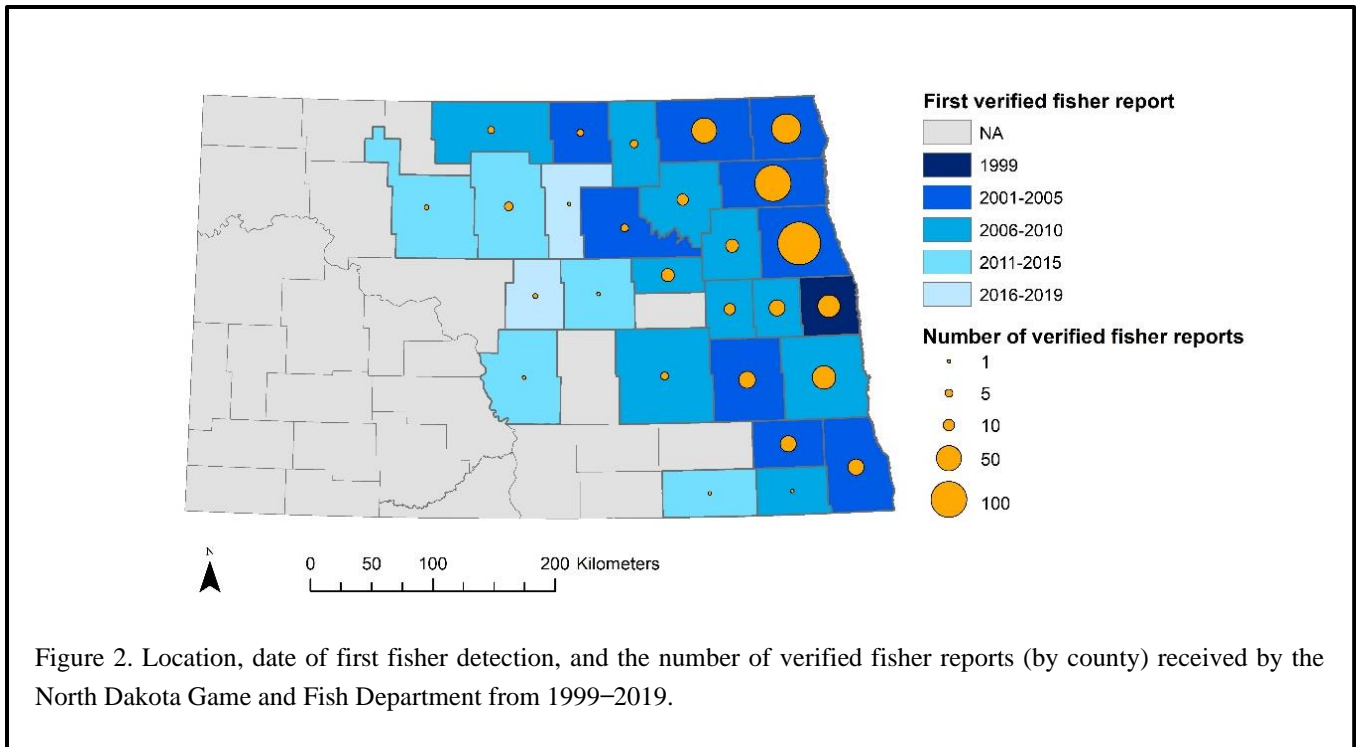
Figure 2. Location, date of first fisher detection, and the number of verified fisher reports (by county) received by the North Dakota Game and Fish Department from 1999−2019.

Table 1. Summary of verified reports of fishers in North Dakota collected by the North Dakota Game and Fish Department from 1999−2019. In 2011 a regulated trapping season was initiated in ND covering approximately the eastern third of ND.

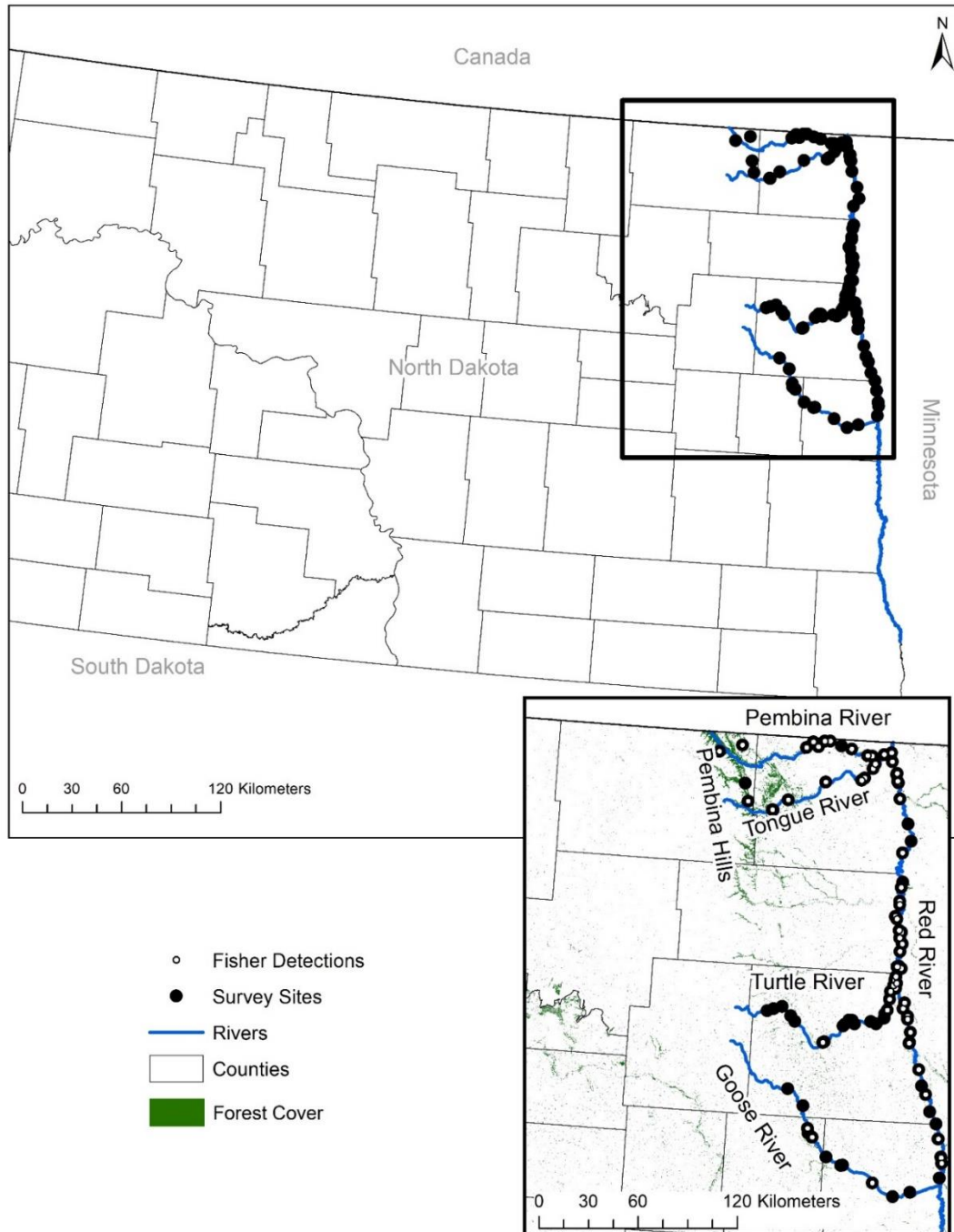| Year	Detections	Male	Female
1999	1	1	0
2000	0	0	0
2001	1	0	0
2002	6	5	0
2003	1	0	0
2004	4	2	1
2005	7	4	0
2006	5	1	3
2007	2	2	0
2008	33	5	8
2009	23	3	7
2010	25	7	10
2011	43	20	17
2012	65	30	25
2013	77	30	26
2014	67	28	28
2015	60	28	24
2016	52	16	23
2017	54	19	29
2018	61	24	29
2019	31	16	11
Total	**618**	**241**	**241**

Figure 3. Study area with survey sites and fisher detection locations from a remote camera study conducted in northeastern North Dakota (ND) during the summer of 2009. White areas within the zoomed in study area represent non-forested areas within ND.

Table 2. Logistic regression results of the full model (Estimate, Standard Error (SE) and *P* value (P)), which contained patch size categories of small (1-50 ha), medium (>50-250 ha), and large (>250 ha), proximity, measured as the distance (in meters) to the nearest forest patch, and interactions between patch size categories and proximity. Results are from data collected in 2009 during a remote camera study in northeastern North Dakota. Note that the small patch size is the intercept/reference.

Covariate	Estimate	SE	*P*
Intercept	0.03	0.22	0.88
Medium	4.14	2.19	0.06
Large	0.04	0.66	0.95
Proximity	<0.00	<0.00	0.62
Medium: Proximity	-0.01	0.01	0.11
Large: Proximity	-<0.00	<0.00	0.58

occurring along the Turtle and Goose Rivers (Figure 3). The results of the logistic regression did not show significance with any covariates or interactions (Table 2). The overall LTD for all sites with a detection patch was 270.7 ± 18.4 (CI 40.0 − 784.0 m), and 376.1 ± 30.0 (CI 102.0−763.0), 220.6 ± 20.1 (CI 40.0−347.0), and 207.7 ± 26.9 (CI 42.0− 784.0) to the nearest small, medium, and large forest patches, respectively. Detections were more common in the northern section of the study area and along the Red River, with fewer detections occurring along the Turtle and Goose Rivers (Figure 3). The results of the logistic regression did not show significance with any covariates or interactions (Table 2). The overall LTD for all sites with a detection was 4.7 ± 0.4 (SE) DD, but LTDs differed among forest patch sizes (Table 3 and Figure 4). The Poisson model displayed that LTD differed among categories with small forest patches receiving detections sooner than medium and large forest patches (Table 3). Predicted model estimates for LTD (in DD) ± Standard Error (95% Confidence Interval: CI) for forest patch categories were 3.9 ± 0.6 (CI 2.9−5.3), 4.7 ± 0.6 (CI 3.6 −6.0), and 5.7 ± 0.7 (CI 4.5−7.3) for small, medium, and large forest patches, respectively.

DISCUSSION

Our evaluation of verified reports demonstrated that fishers have occupied portions of North Dakota since at least 1999 when the first contemporary detection occurred along the ND/MN border in east-central ND, with reports from subsequent years demonstrating continued range expansion since 1999 (Figure 2). Most evidence of fishers were from northeastern ND, but verified reports were documented throughout most of the eastern third of the state, with more recent verified reports demonstrating expansion into some central and southern counties (Figure 2). The initial arrival of fishers in ND likely was facilitated by natural expansion of well-established populations in northeastern MN along forested riparian corridors extending through the prairie of western MN to the Red River (Triska 2010; Triska *et al.* 2011). The regulated trapping season initiated on fishers in ND in 2011 contributed to the subsequent and ongoing increase in fisher reports. Nonetheless, fishers are clearly persisting and expanding in ND.

Areas occupied by fishers in ND contrast substantially with established habitat paradigms for fishers (e.g., large, continuous forests comprised largely of conifers, presence of coarse woody debris; Coulter 1966; Kelly 1977; Powell 1977; Allen 1983). However, in this study, we assessed the general presumption that fishers require large, continuous forest as they are conditions associated with habitat paradigms for fishers that are limited in ND. Surprisingly, our remote camera surveys demonstrated that neither forest patch size nor proximity influenced the detection of fishers. In fact, fishers were detected among forest patches as small as 1 ha and isolated from the nearest forest patch by as much as 785 m. The distribution of forests in western and southern MN is similar to ND and, likewise, fishers have recently
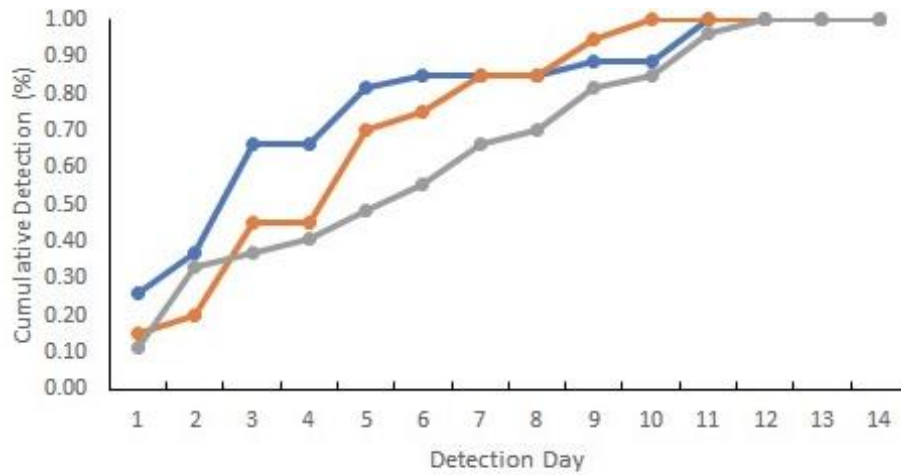
Figure 4. Comparison of Detection Day (i.e., days until detection: Latency to Detection) for fishers differed among the patch categories during the summer of 2009. The categories were defined as small (1-50 ha, *n*=27), medium (50-250 ha, *n*=20), and large (250+ ha, *n*=30). Results are from data collected in 2009 during a remote camera study in northeastern North Dakota.

Table 3. Latency to detection (LTD) means, Standard Deviations (SD), number of observations and Poisson output (Estimate, Standard Error (SE), 95% Confidence Interval (CI) and associated *P* value (*P*)) based on patch size. Results are from data collected in 2009 during a remote camera study in northeastern North Dakota.

Patch size	Mean	SD	n	Estimate	SE	CI	*P*
Small	3.89	3.18	28	1.36	0.15	1.06-1.66	<0.01
Moderate	4.65	2.72	20	1.54	0.13	1.29-1.79	<0.01
Large	5.74	3.64	30	1.75	0.12	1.51-1.98	<0.01

expanded and maintained populations in these areas (Erb 2008). Occupation of riparian forests by fishers in substantial portions of ND and western and southern MN suggests that the species may exhibit considerably more plasticity in habitat associations than previously reported (Coulter 1966; Kelly 1977; Powell 1977; Allen 1983).

The main intent of our study was to gain insight on the occurrence and general patterns of fisher detections in northeastern ND. Our application of the logistic regression was to determine if fisher detections differed by forest patch size and proximity to the nearest adjacent forest patch, not to make overall generalization or imply causative factors about fisher habitat use in the patchy, linear riparian forest that predominated the study area. We recognize and expect that

fishers moving among adjacent patches could have resulted in the detection of the same fishers among adjacent patches during our camera cycles. Hence, our study is not suitable (or designed or intended) for interpreting implications of factors such patch size, interactions among patches, proximity of patches, density of patches, or interactions among such factors in relation to the sustainability of fisher population in northeastern ND. Nonetheless, camera detections during our study clearly demonstrate that fishers in the region are widely distributed and occur in forested patches of various sizes and at various distances from the next forested patch. Achieving these outcomes necessitated the consistent and repeated movement of fishers through non-forested portions of the landscape (see Figure 3). Regardless of the totality of
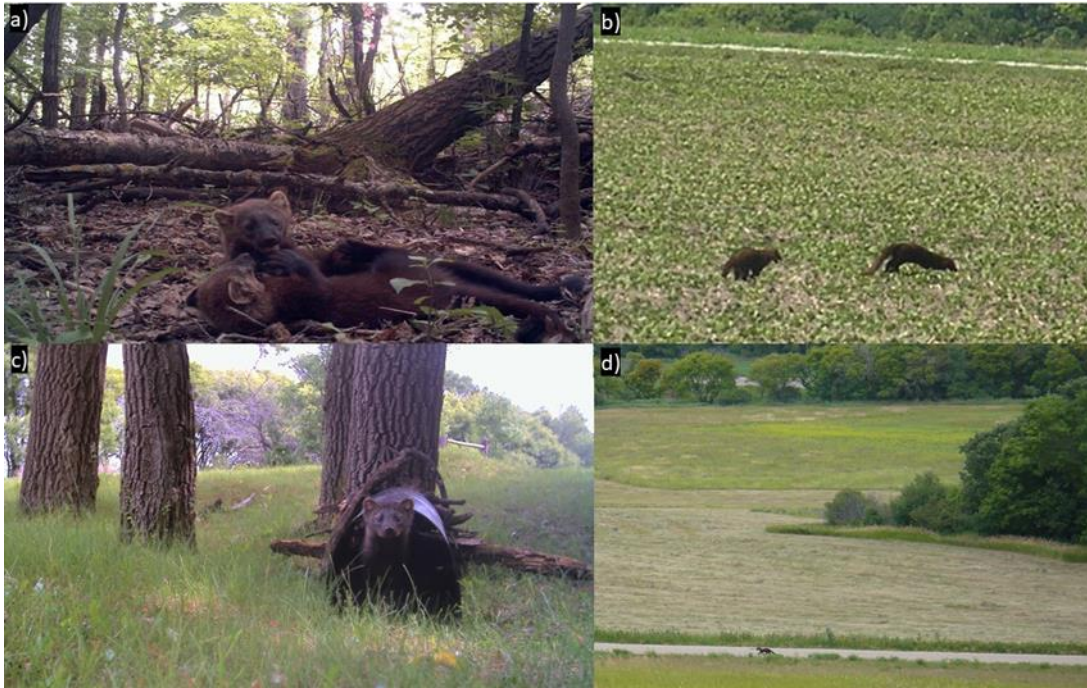
Figure 5. Photos of fishers in northeastern North Dakota including juvenile fishers that interacted at a survey site along the Pembina River captured at a remote camera site during 2009 (a), fishers travelling through a soybean field along the Red River (© S. Fischer) (b), a fisher captured along the Tongue River in the limited forest within a cattle pasture during track-plate and remote-camera sampling in 2008 (Loughry *et al.* 2012) (c), and a fisher spotted traveling along a road near the Sheyenne River during field work in 2009 (© M. Triska) (d).

factors that may influence the observed detection patterns, our study outcomes clearly demonstrate a divergence from habitat conditions previously identified as essential for this species.

Furthermore, although fisher detections were similar among forest patch sizes, LTD was lowest in small forest patches (Figure 4). We suspect difference in the time until detection was simply the result of fishers being more likely to quickly encounter a remote camera site while traversing smaller areas, potentially to reach larger, preferred forest patches. We have no reason to suspect that LTD reflects the likelihood of detecting a fisher occupying forest patches of various sizes. For example, although the Pembina Hills area was by far the largest patch assessed in the study (34,180 ha) fishers were detected at 6 of 8 surveys sites widely dispersed in the area.

Our study was not designed to assess the viability of the fisher population occupying ND. However, the majority of fisher carcasses examined by the NDGF were <2 years old, an outcome that could suggest fishers in ND (and western and southern MN) are the result of juvenile dispersal from more suitable habitats rather than an indication of an established, viable population. Such an outcome may indicate that habitats in ND are ultimately sinks or ecological traps for fishers (i.e., not self-sustaining; Pulliam 1988; Battin 2004). However, male dispersal typically precedes female dispersal (Matthews *et al.* 2013), and a newly established population thus would be expected to have a higher proportion of males, which was not the case among the carcasses examined (fishers in all age classes reported ranged from M:F ratios of 56:44 in age class 0−1 to 0:100 for age classes >7 years).

Considering the distance of sites occupied by fishers in ND from what would be considered more traditional fisher habitat (i.e., >100 km straight-line distance from northeastern MN to the ND border; northeastern MN is presumed to be the ultimate source of fishers pioneering western and southern MN, and ND), fishers in ND are very likely not being sustained by dispersal from traditional habitats. We thus believe that fishers now occurring in ND are the result of reproduction in the region (ND and associated areas in MN), which is supported by the detection of young fishers at 7 of our survey sites on 4 drainages (Pembina, Tongue, Red and Turtle Rivers; see Figures 1 and

5) and reports of fishers rearing litters in barns and under porches (Game Warden Gary Rankin, 2009, personal communication). We realize that evidence of reproduction does not necessarily equate to long-term viability and acknowledge that the fisher population now in ND may ultimately represent a sink population (Pulliam 1988), requiring at least some level of recruitment from a source population, such as that in northeastern MN. Making such a determination would require a longer-term assessment of persistence of fishers in the area, accompanied with supporting demographic information. Regardless of population persistence, fishers in ND have exhibited greater habitat plasticity than typically attributed to the species (de Vos 1952; Coulter 1966; Kelly 1977; Powell 1993; Allen 1983; Weir and Harestad 2003; Jones and Garton 1994; Zielinski *et al.* 2004) and their occurrence in the region demonstrates the value of linear, riparian forests to forest-associated species in otherwise non-forested landscapes (Figure 5). Hence riparian forests should be considered critical habitat for the persistence and expansion of fishers in ND and similar landscapes elsewhere in the region.

In general, habitat paradigms may develop from inductive reasoning where inferences are derived from observations under specific landscape conditions within a narrow portion of a specie's range. Therefore, the development of habitat paradigms is understandably influenced by the distribution of a species within its historic range. Incomplete paradigms of habitat requirements of a species may develop from assessments or observations conducted over a small portion of the entire range of a species or following the range reduction of a species (e.g., reductions from overuse by humans). Development of incomplete paradigms is more likely if the portion of the range assessed does not represent the totality of habitat conditions encountered in the historic range, such as with fishers. Hence, a panchreston may result and habitat may be defined as non-habitat instead of unused habitat due to species absence caused by their restricted population (Hall *et al.* 1997). Overtime, the range of a species may expand to occupy areas with conditions considered unsuitable based on current paradigms, necessitating an update of the habitat requirements of the species to accurately cover their potential range. In some cases, these revisions may infer greater habitat plasticity than previously presumed. Fishers in our study demonstrated the ability to use sparse, linear, deciduous forest patches of varying proximity, suggesting that fishers may be a species capable of exploiting a greater range of habitat than indicated by prevailing habitat paradigms.

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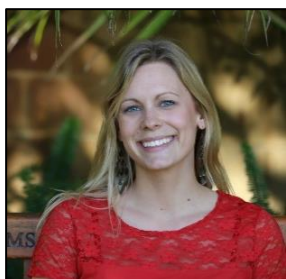
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ABOUT THE AUTHORS

Maggie Triska is a conservation biologist at Round River Conservation Studies. Her research pairs field studies with spatial models to assess factors and processes influencing species' distributions over time. She has conducted research on a variety of taxa including plants, invertebrates, reptiles and mammals in North America and Australia. Currently, she works on assessing habitat use and selection of terrestrial mammals including grizzly bear (*Ursus arctos*), caribou (*Rangifer tarandus*), moose (*Alces alces*) and Dall's sheep (*Ovis dalli*) in northern Canada to inform indigenous protected and conserved areas planning.

Steven Loughry completed BS and MS degrees in Wildlife Biology in the Department of Biology and Natural Resources at Frostburg State University. Steve conducted research with both American martens (*Martes americana*) and fishers in North Dakota, focusing on landscape-level detection patterns and comparing the efficacy of track plates and remote cameras in detecting the respective species. Steve is now an environmental consultant, serving as the project manager for Triangle Contracting in Maryland.

Tom Serfass is a Professor of Wildlife Ecology and Graduate Program Coordinator in the Department of Biology and Natural Resources at Frostburg State University, and the North American Coordinator of the IUCN's Otter Specialist Group. Tom's research and conservation activities have focused largely on the design, implementation, and evaluation of factors contributing to successful, publicly supported wildlife restoration programs. For example, he conceived and coordinated the Pennsylvania River Otter (*Lontra canadensis*) and Fisher Reintroduction Projects. During the past 20 years, he mentored the completion of >40 graduate students involved with research ranging from evaluating the fates of river otters reintroduced in western New York to assessing the natural history and conservation value (potential as flagship species) of spotted-necked otters (*Lutra maculicollis*) and other wildlife at Rubondo Island National Park, Lake Victoria, Tanzania. Currently, Tom is working in the Greater Yellowstone Ecosystem to assess the potential of river otters to serve as a flagship species to promote aquatic conservation and education.