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# Status of Pacific Martens (*Martes caurina*) on the Olympic Peninsula, Washington

## Abstract

Pacific martens (*Martes caurina*) remain common in montane regions of the Pacific states, yet their distribution and status on the Olympic Peninsula, Washington, is uncertain. Between 1968–2008, six reliable marten detections exist; a dead juvenile female (2008) indicates martens were reproducing on the Peninsula within the last decade. To assess the status of martens, we describe carnivore surveys conducted from 1991–2008 ($n$ = 223 stations). Additionally, we present results from three survey efforts we conducted from 2013–2016 ($n$ = 747 stations). Although a suite of carnivore species was detected, surveys from 1991–2008 failed to detect either martens or fishers. Surveys from 2013–2016 detected reintroduced fishers, and resulted in two marten detections near Mt. Olympus, 4 km apart. A marten was photographed opportunistically near Mt. Cruiser in 2015, 44 km from Mt. Olympus. Altogether, nine reliable detections of Pacific martens were obtained between 1968 and 2016, including three since 2008. Evidence suggests martens are absent from the lower elevation regions they once occupied and occur at exceedingly low densities at higher elevations. To understand the trend in marten populations on the Peninsula and develop appropriate conservation strategies, additional broad- and fine-scale surveys using detection devices that enable the genetic identification of individuals will be needed.

**Key Words:** distribution, *Martes caurina*, Olympic Peninsula, Pacific marten

## Introduction

Pacific martens (*Martes caurina*) once occurred throughout coastal forests in northern California, Oregon, and Washington (Zielinski et al. 2001). Coastal marten populations appear to be reduced in range and more isolated than they were historically (e.g., Moriarty et al. 2016), and some appear to have been extirpated (e.g., along the northern Oregon coast, Zielinski et al. 2001). Historically, martens occurred from sea level to treeline on the Olympic Peninsula and in coastal Washington (Bailey 1936, Grinnell et al. 1937, Hagmeier 1956), but little else is known about these populations. Nonetheless, recent evidence of population contraction on the Olympic Peninsula and elsewhere on the Pacific Coast raises concerns about the long-term viability of coastal Pacific marten populations (Zielinski et al. 2001).

The Olympic Peninsula in western Washington (14,412 km$^2$) is bordered by the Pacific Ocean to

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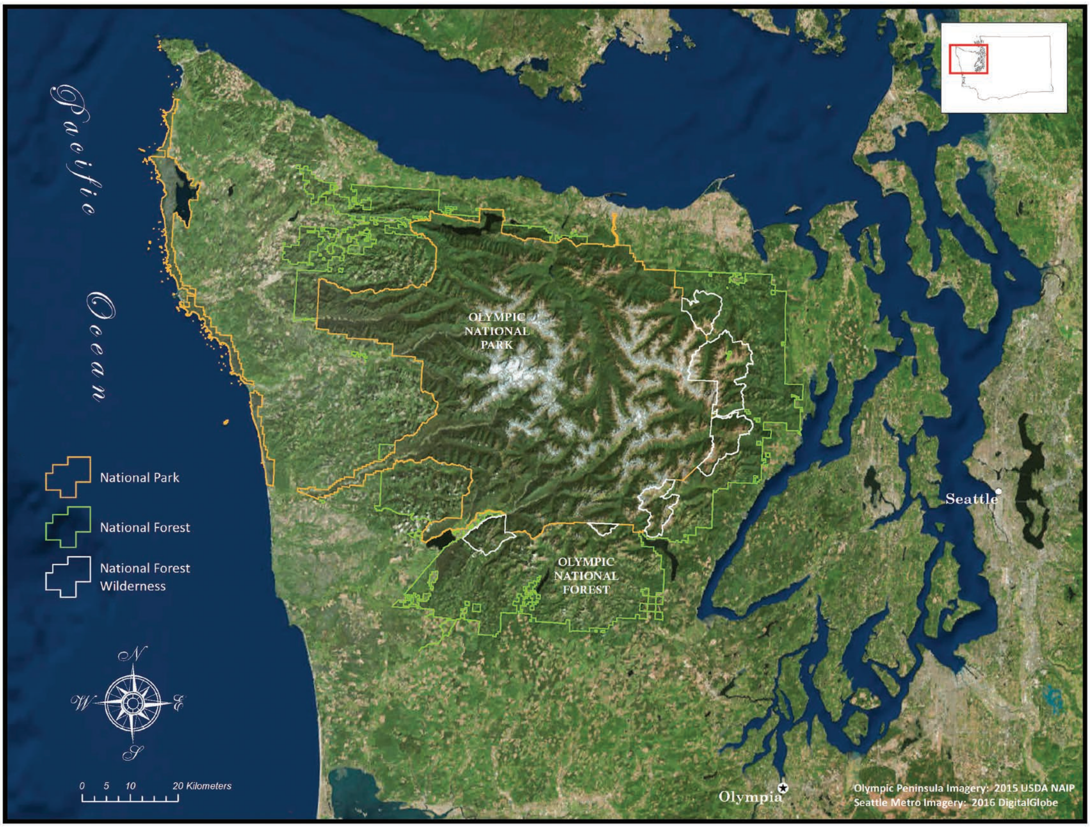


Figure 1. The Olympic Peninsula is surrounded by the Pacific Ocean to the west, Strait of Juan de Fuca to the north, Hood Canal and Puget Sound to the east. Extensive vegetation modification from timber harvest or land conversion has occurred at lower elevations and to the south. Image data: ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and GIS User Community.

the west, the Strait of Juan de Fuca to the north, and Hood Canal and Puget Sound to the east (Figure 1). The Olympic Peninsula was ecologically isolated from other portions of Washington at various times during the Pleistocene Epoch by glacial advances and outwash (Gavin and Brubaker 2015); today, the region is physically isolated by salt water on three sides, and by highways and urban or agricultural development in the Chehalis River valley to the south (Figure 1). A unique fauna exists on the Peninsula that reflects this history of genetic isolation. Twenty-nine plant and animal taxa are endemic to the Olympic Peninsula, including the Olympic marmot (*Marmota olympus*), a subspecies of Mazama pocket gopher (*Thomomys mazama melanops*), and Olympic torrent salamander (*Rhyacotriton olympicus)*. The Peninsula also functions as a land-bridge island (Newmark 1995), whereby 13 species present in the nearby Cascade Range are absent from the Olympic Mountains, including the wolverine (*Gulo gulo*), Canada lynx (*Lynx canadensis*), and Cascade red fox (*Vulpes vulpes cascadensis*) (Gavin and Brubaker 2015). Other species, including the fisher (*Pekania pennanti*) and gray wolf (*Canis lupus*) were indigenous to the Peninsula but were extirpated in the early to mid-1900s (Lewis and Stinson 1998). Populations of the Olympic marmot and Mazama pocket gopher have experienced localized extinctions and range contractions on the Peninsula since the early to mid-1900s (Stinson 2005, Griffin et al. 2008). Genetic structuring of many mammals in this region reflect a history of geographic isolation mediated by long-term climatic variation (Welch 2008, Chavez and Kenagy 2010, Kerhoulas et al. 2015), yet their effects on the population dynamics of martens on the Olympic Peninsula remain poorly understood.

Fishers and martens once occurred sympatrically throughout low- to mid-elevation forests on the Olympic Peninsula (Dalquest 1948). To restore a portion of the historical carnivore assemblage, fishers were reintroduced to the Olympic Peninsula from 2008–2010 via translocations from nearby populations in British Columbia (Lewis 2006, Lewis et al. 2016). Although martens occur in the Cascade Range of Washington, there is increasing concern about the persistence of martens on the Peninsula, similar to that of the previously extirpated fisher. Catch records submitted by registered trappers in Washington indicated that 94 martens were legally trapped between 1940–2018 in three of the four counties that comprise the Olympic Peninsula (Clallam, Jefferson, and Mason counties; described in Zielinski et al. 2001), including 83 in the 1940s, 2 in the 1950s, and 9 in the 1960s. Four martens were trapped in Pacific County (located south of the Olympic Peninsula along the coast) in the 1970s, but no martens have been legally trapped on the Peninsula or along the southwest coast of Washington since that time, even though trapping of martens remains legal throughout the state.

In recent decades, few verifiable records of marten occurrence have been obtained on the Olympic Peninsula, despite extensive survey efforts targeting forest carnivores (fishers and martens). Between 1991–2008, four surveys ($n$ = 223 survey stations; Figure 2, Table 1) were conducted using remote-sensor cameras (hereafter, cameras), track plates, or snow transects to detect carnivores, but none detected martens or fishers. Only six reliable records of marten occurrence on the Peninsula exist from 1968 to 2008 (Figure 2) and all were obtained opportunistically, including two dead animals (late-1970s, 2008; Keith B. Aubry, USDA Forest Service, personal communication), photographs of live animals (1968, 1988; Keith B. Aubry, USDA Forest Service, personal communication), and two live animals captured incidentally as part of a small mammal study (1990; Brian L. Biswell, [retired], USDA Forest Service, personal communication). Although the 1990 record is not verifiable (no specimens collected and no photographs), the researchers had the animals "in hand", giving strong credence to these records. The 2008 record is a juvenile female marten that was found dead on a hiking trail near Mt. Rose in the southeast corner of the Olympic Peninsula, indicating that martens were likely reproducing in that portion of the Peninsula within the last decade. Due to the current isolation of the Peninsula (Figure 1) this individual was unlikely to represent a dispersal event from elsewhere (e.g., the Cascade Range).

Because few marten detections were obtained during almost 20 years of surveys, there was a high degree of uncertainty about the long-term viability of marten populations on the Peninsula after 2008. Nonetheless, most of the surveys conducted prior to 2008 involved a relatively small number of survey stations that were limited in geographic extent. Prior surveys may have failed to detect martens due to the species' small home ranges and potentially low abundance. We hypothesized that a remnant population of martens may persist either in coastal forests with dense shrub cover as they do in southern Oregon (Moriarty et al. 2016, Linnell et al. 2018), or in high-elevation areas near treeline, neither of which were a focus of previous survey efforts. Our objective was to evaluate the current status of Pacific martens on the Olympic Peninsula by deploying detection devices in areas where martens were present historically, and in areas that were underrepresented in previous surveys.

## Methods

### Study Area

Elevations on the Olympic Peninsula range from sea level to 2,427 m atop Mt. Olympus. The mountainous core of the Olympic Peninsula includes lands administered by Olympic National Park and Olympic National Forest (Figure 1). Additionally, a narrow strip (< 10 km wide) of Olympic National Park extends approximately 75 km along the Pacific coast on the Peninsula. Most lands within Olympic National Park have been managed for resource and wilderness preservation since the Park's creation in 1938, whereas Olympic National Forest

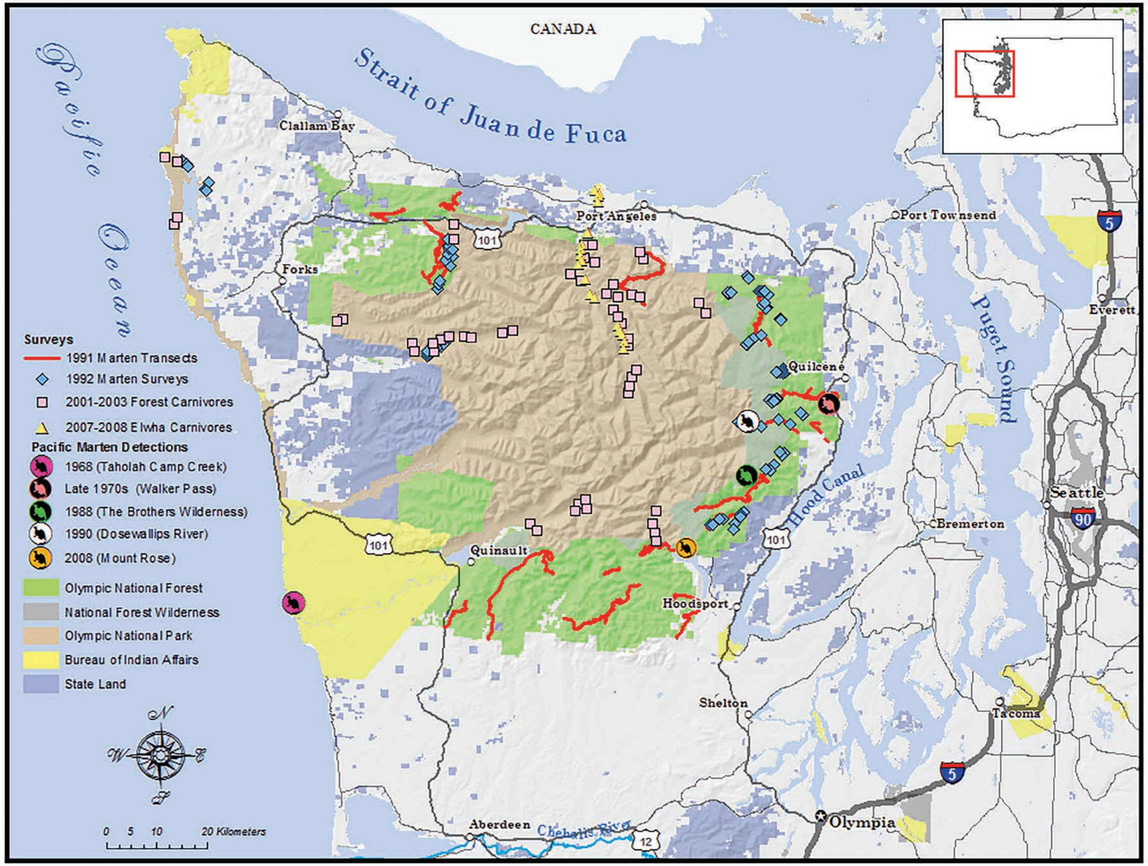


Figure 2. Locations of early carnivore surveys and Pacific marten detections on the Olympic Peninsula from 1968 to 2008. Remote-camera surveys targeting martens were conducted in the summer of 1991 (red transects were digitized from field reports; exact camera locations are unknown), and from March to October 1992 (blue diamonds). During the winters of 2001–2002 and 2002–2003, remote-camera surveys targeting a suite of forest carnivores were conducted in Olympic National Park (pink squares; Happe et al. 2005). Surveys were also conducted in the riparian zone of the Elwha River to document mesocarnivore distributions before dam removal (yellow triangles; Jenkins et al. 2015). A photograph of a marten taken in 1968 on the road from Taholah to Camp Creek was recently discovered by Carl Ward of the Washington Department of Transportation (bright pink mustelid symbol). In the late 1970s, a marten was killed by vehicle strike near Quilcene (pale pink mustelid symbol). In 1988, a marten was photographed at close range in The Brothers Wilderness (green mustelid symbol). In 1990, small mammal researchers reportedly live-trapped and released two martens near the Dosewallips River (white mustelid symbol; Brian L. Biswell, USDA Forest Service (retired), personal communication). In 2008, a dead juvenile female marten was found on the trail to Mt. Rose (orange mustelid symbol).

TABLE 1. Surveys for forest carnivores on the Olympic Peninsula, Washington from 1991 to 2016 (see Figures 2 and 3).

| Survey | Year(s) | Sample Units | Survey Stations | Months | Median Elevation (m) | Elevation Range (m) | Average Sampling Days Per Station | Trap Nights | Photos |
|---|---|---|---|---|---|---|---|---|---|
| Marten transects | 1991 | | 51 | Summer | | | | | |
| Marten surveys | 1992 | | 99 | Mar–Oct | | | | | |
| Forest carnivores | 2001–2003 | | 52 | Dec–Apr | 550 | 28–1,600 | 28 | 2,193[a] | 1,270 |
| Elwha carnivores | 2006–2008 | | 21 | Jul–Sep | 98 | 0–549 | 14.4 | 10,050 | 1,281 |
| Fisher monitoring (this study) | 2013–2016 | 179 [b] | 537 | Jun–Oct | 283 | 3–1,596 | 42 | 39,284 [c] | 330,552 |
| Marten citizen-science (this study) | 2013–2014 | 16 | 41 | Jan–Apr | 600 | 246–1,374 | 45 | 1,400 | 21,842 |
| Marten, high-density, coastal (this study) | 2015–2016 | 44 | 85 | Nov–Mar | 38 | 0–106 | 100 | 11,988 | 77,300 |
| Marten, high-density, montane (this study) | 2016 | 43 | 84 | Jul–Sep | 551 | 50–1,600 | 70 | 5,909 | 319,749 |
| Total | 1991–2016 | | 970 | | | | | 70,824 | 751,994 |

[a] Report states that set-ups were out for 3,766 nights, but only 2,193 nights had fully operational survey stations (bait there, camera working, film in camera).
[b] 115 sample units were re-sampled on two occasions with a 2-year interval between sampling and two sample units were surveyed three times over four years.
[c] From annual reports: # station/visit events * mean sampling interval, summed over four years, occupancy study only.

is managed for multiple uses (e.g., recreation, timber production) and wilderness preservation within designated areas. Lower elevation areas surrounding national park and national forest lands are managed for multiple uses by the state of Washington, private land-owners, and several tribes, with a focus on timber production.

The Peninsula has a maritime climate characterized by relatively dry, warm summers (June average minimum [10 °C] and maximum [19 °C] temperatures) and wet, cool winters (January average minimum [3 °C] and maximum [8 °C] temperatures; Peel et al. 2007). Precipitation ranges from 300–500 cm annually on the west slope of the mountains, but declines to 40 cm in the northeastern corner on the leeward side of the Olympic Mountains (Gavin and Brubaker 2015). Most precipitation occurs from October through March, primarily as rain at elevations < 300 m, and as snow at elevations > 800 m. Forest associations are dominated by Sitka spruce (*Picea sitchensis* (Bong.) Carrière), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), western redcedar (*Thuja plicata* Donn ex D. Don), bigleaf maple (*Acer macrophyllum* Pursh), and red alder (*Alnus rubra* Bong.) at the lowest elevations (< 250 m), western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) at low to mid-elevations (< 1,100 m), Pacific silver fir (*Abies amabilis* (Douglas) James Forbes) at mid-elevations (1,100–1,300 m), and mountain hemlock (*Tsuga mertensiana* (Bong.) Carrière) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) at high elevations (>1,300 m) (Franklin and Dyrness 1973). Areas dominated by Sitka spruce forests on the western coast and floodplains are considered temperate rainforests (Franklin and Dyrness 1973). These spruce forests are renowned for the large size and productivity of overstory trees (Van Pelt et al. 2006), an abundance of epiphytic plants (Nadkarni 1984), and a highly variable understory mediated through complex interactions among canopy gap dynamics, dead and downed wood on the forest floor, and intense herbivory by Roosevelt elk (*Cervus canadensis roosevelti*) and black-tailed deer (*Odocoileus hemionus*) (Schreiner et al. 1996). Hardwood communities dominated by red alder, bigleaf maple, and black cottonwood (*Populus trichocarpa* Torr. & A. Gray ex Hook.) are common in riparian forests along major rivers (Fonda 1974, Van Pelt et al. 2006). Young regenerating stands of western hemlock, Douglas-fir, and Sitka spruce are common on lands that were logged recently outside the boundaries of Olympic National Park (Figure 1).

## Carnivore Surveys

We conducted three surveys since 2013 that targeted martens and other forest carnivores on the Olympic Peninsula. From 2013–2016, we systematically surveyed the Peninsula primarily to document the distribution of a recently reintroduced fisher population, but the camera network provided extensive coverage for detecting martens. In addition, we conducted 'citizen-science' (2013–2014) and 'high-density' surveys targeting martens in both coastal and montane regions (2015–2016) of the Peninsula that were under-surveyed previously (Table 1).

*Fisher Reintroduction Monitoring*—We established a grid of 24 $km^2$ hexagonal cells throughout the Peninsula at elevations < 1,435 m. We surveyed in every other hexagon, resulting in 179 hexagons surveyed from 2013–2016, with 65% surveyed two or more times (Figure 3). In each hexagon, we established three survey stations >1 km apart in mid- to late-seral forests, or in forested stands that most closely matched those conditions; the three stations were considered to be a sample unit (see Happe et al. 2015 for detailed methods). Each station contained a camera (2014 Bushnell® Trophy Cam HD, black LED flash; Overland Park, KS) and a hair-snaring device for collecting samples for genetic analysis (data not shown). Stations were baited with raw chicken and we applied a long-distance olfactory lure in view of the camera (Caven's Gusto, Minnesota Trapline Products, Inc., Pennock, MN). We visited each station three times, with 14-day intervals between visits, resulting in 6 weeks of sampling in each hexagon. Surveys were conducted primarily from early June to late October of each year (Table 1).

*Citizen-Science Marten Surveys*—Our second effort involved a collaboration with a non-profit organization, Adventure Scientists (Bozeman,

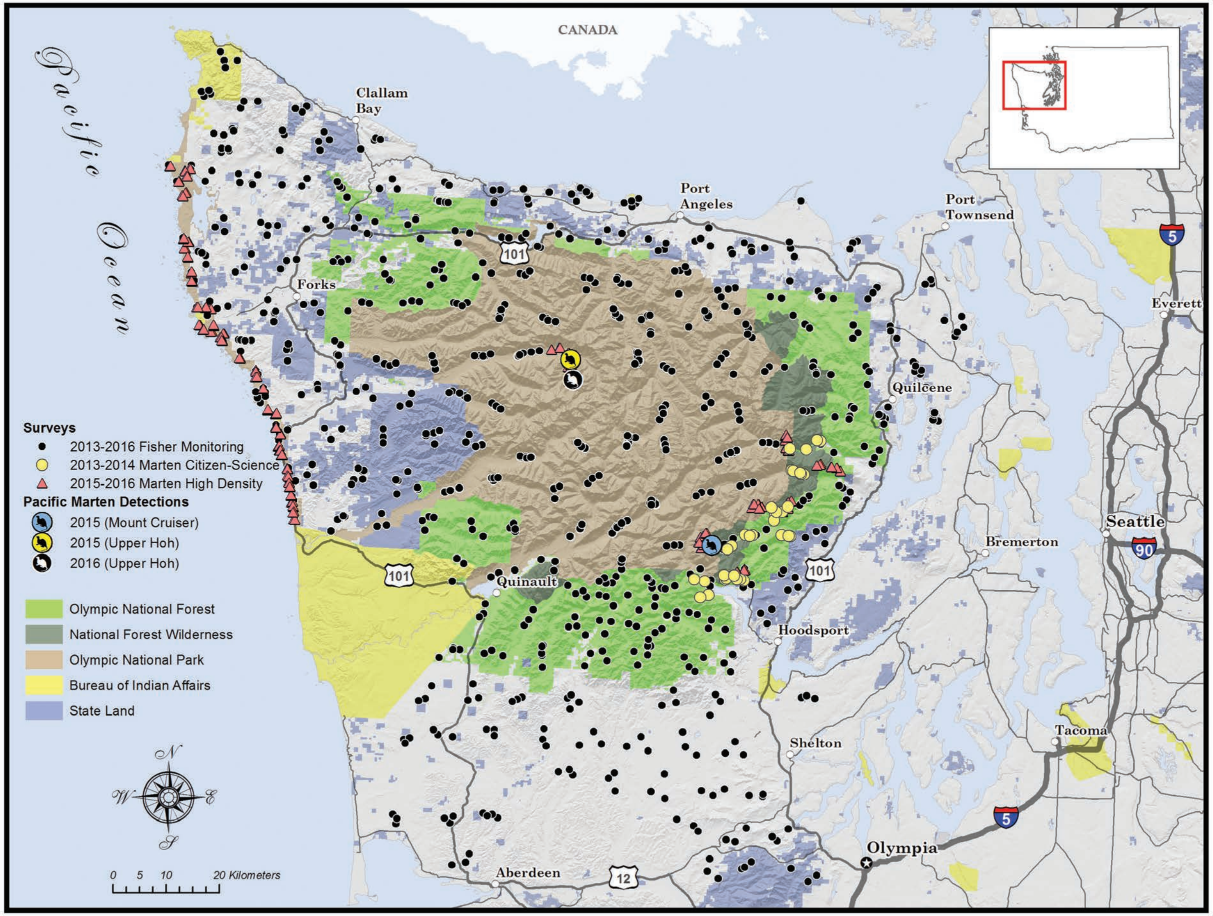


Figure 3. We conducted remote-camera surveys throughout the Olympic Peninsula in Washington from 2013–2016 (black circles) to monitor the distribution of reintroduced fishers. We conducted remote-camera surveys targeting martens during the winter of 2013–2014 (yellow circles). We surveyed coastal and montane areas at higher densities, specifically focused on martens, from 2015–2016 (pink triangles). We detected one marten near Mt. Olympus in the Upper Hoh River watershed during 2015 (yellow mustelid symbol), and we obtained a series of photographs at a nearby camera during 2016 (black mustelid symbol). Additionally, in 2015, a photograph of a marten was taken opportunistically by a mountaineer near the summit of Mt. Cruiser (blue mustelid symbol).

MT), and consisted of low-density camera surveys conducted during the winter (January–March 2013, January–April 2014) (Table 1). Surveys were located in high-elevation, difficult-to-access areas of Olympic National Forest where martens had been detected previously (Figure 3). We trained volunteers to carry out all aspects of project work, from the installation and monitoring of camera stations to data management. Volunteers installed two cameras (Reconyx Rapidfire or Hyperfire, Holmen, WI or Bushnell HDMax, Overland Park, KS) using a protocol similar to the fisher monitoring surveys described above, but with cameras placed > 1.6 km apart for a total of 41 survey stations in approximately 16 areas, which we considered to be sample units (6 sample units, 17 survey stations in 2013 and 10 units, 24 stations in 2014; Figure 3). Each survey station was baited with raw chicken or beaver and a long-distance olfactory lure. In 2014, hair snares were also installed at four camera stations where fishers were documented on the first check at two of the four stations. Camera stations were placed within 750 m of roads and trails, and crews checked cameras, replaced bait, and downloaded data every 2–3 weeks.

*High-Density Marten Surveys*—Our third effort consisted of high-density camera surveys conducted in two disjunct study areas on the Olympic Peninsula: 1) unharvested forests along the Pacific coastal strip of Olympic National Park from Lake Ozette to the Quinault Indian Reservation, and 2) high-elevation montane areas in Olympic National Forest and Olympic National Park (Figure 3). Coastal surveys were located in areas of unknown marten occupancy that were ecologically similar to areas in Oregon where the presence of martens was recently documented (Moriarty et al. 2016). High-elevation surveys occurred in six focal areas located near recent verifiable marten detections (e.g., photograph or carcass) or unverifiable but highly reliable detections (e.g., martens live-trapped and released by experienced mammalogists). We established between four and nine sample units each consisting of two camera stations in each focal area, depending on accessibility.

We randomly located 250 potential sample units in both study areas that were ≥ 750 m apart and ≤ 750 m from a trail (Beyer 2012). We excluded potential sample units that were too remote or logistically challenging to access, such as coastal areas where technicians could be stranded by high tides. This resulted in 86 and 75 potential sample units in the coastal and montane study areas, respectively. Each sample unit consisted of two baited remote-camera stations, with the first station placed at the randomly-located point, and the second station placed 100–300 m from the first station along a random compass bearing. All montane surveys were conducted in designated wilderness areas; thus, we located all remote-camera stations > 200 m from campsites and lakes, > 50 m from trails, and out of sight from trails or campsites, in accordance with our permits.

We conducted coastal surveys during the winter months (November 2015–March 2016; Table 1) to maximize detection probability, which is generally higher for martens in the winter than in the summer (Zielinski et al. 2015). At each survey station, we installed a camera 0.5 m above the ground in microsites containing dense shrub cover (> 50%) and baited it with one chicken drumstick and one can (156 g) of fish-flavored cat food. We applied 30 ml of olfactory lure (Gusto, Minnesota Trapline Products, Pennock, MN) mixed with glycerin in a 4:1 ratio at each station. To extend its effectiveness during the winter, we placed the lure mixture on a 2 $cm^3$ sponge in a punctured film canister. We conducted montane surveys during summer (July–September 2016; Table 1), due to the inaccessibility of high-elevation areas of the Olympic Peninsula in winter. We installed survey stations in a manner similar to our coastal surveys, but did not add glycerin to the scent lure. Instead, we applied 10 ml of lure to sponges or on branches > 1 m above the camera station in an area where wind could carry the scent.

## Results

During fisher monitoring surveys, we surveyed 179 sample hexagons and a total of 537 camera stations. We resampled 115 hexagons on two occasions with a 2-year interval between occa-

TABLE 2. Taxa identified in surveys designed to detect martens and fishers on the Olympic Peninsula, 2013–2016. We report the percentage of sample units where each species was detected and verified. Percent detection and occupancy rates estimated from the fisher monitoring effort will be reported elsewhere (Patricia J. Happe, USDI National Park Service, personal communication). We conducted citizen-science surveys during 2013–2014, coastal surveys during 2015–2016, and montane surveys in 2016, all of which targeted Pacific martens.

| | | Percentage of sample units with verified species detections | | |
|---|---|---|---|---|
| Taxa | Fisher Monitoring (Species detected) | Citizen- Science Survey | High- Density Coastal Survey | High-Density Montane Survey |
| Bird (any avian species) | x | 39% | 88% | 98% |
| Mouse or unknown rodent | x | 15% | 98% | 95% |
| Unknown squirrel (Sciuridae) | | 4% | 7% | 70% |
| Chipmunk (*Neotamias* spp.) | x | 0% | 0% | 95% |
| Douglas squirrel (*Tamiasciurus douglasii*) | x | 27% | 9% | 67% |
| Northern flying squirrel (*Glaucomys sabrinus*) | x | 24% | 11% | 84% |
| Woodrat (*Neotoma* spp.) | x | 0% | 0% | 47% |
| Snowshoe hare (*Lepus americanus*) | x | 10% | 7% | 42% |
| Mountain beaver (*Aplodontia rufa*) | x | 0% | 0% | 14% |
| Unknown weasel (*Mustela* spp.) | x | 7% | 14% | 58% |
| Short-tailed weasel (*Mustela erminea*) | x | 4% | 68% | 2% |
| Long-tailed weasel (*Mustela frenata*) | x | 2% | 7% | 2% |
| Western spotted skunk (*Spilogale gracilis*) | x | 2% | 44% | 9% |
| Pacific marten (*Martes caurina*) | x | 0% | 0% | 2% |
| American mink (*Neovison vison*) | x | 2% | 5% | 0% |
| Fisher (*Pekania pennanti*) | x | 10% | 58% | 0% |
| Virginia opossum (*Didelphis virginiana*) | x | 0% | 0% | 2% |
| Northern raccoon (*Procyon lotor*) | x | 0% | 23% | 5% |
| Northern river otter (*Lontra canadensis*) | x | 0% | 2% | 0% |
| Bobcat (*Lynx rufus*) | x | 51% | 7% | 53% |
| Coyote (*Canis latrans*) | x | 20% | 9% | 7% |
| Mountain lion (*Puma concolor*) | x | 5% | 9% | 19% |
| Black bear (*Ursus americanus*) | x | 0% | 5% | 79% |
| Deer (*Odocoileus* spp.) | x | 20% | 9% | 47% |
| Roosevelt elk (*Cervus canadensis roosevelti*) | x | 2% | 0% | 12% |
| Total sample units | 179 | 16 | 44 | 43 |

sions, and two hexagons three times over 4 years. Cameras were functional for an average of 43 ± 5 days ($\bar{x}$ ± SD; range = 30–130 days), yielding 39,284 trap nights and 330,552 images (Table 1). We detected a single marten near Mt. Olympus in the Upper Hoh River watershed in 2015 (Figure 3).

During citizen-science marten surveys, we surveyed 16 sample units containing 41 camera stations (Table 1, Figure 3). The 17 camera stations in 2013 were functional for an average of 47 ± 19 days (range = 21–78 days). The 24 cameras stations in 2014 were functional for an average of 43 ± 20 days (range = 11–76 days). We did not detect any martens (Table 2).

During high-density marten surveys, we surveyed 44 sample units containing 85 camera stations in the coastal study area for 35–111 days, and 43 sample units containing 84 camera stations in the montane study area for 57–89 days (Table 1). We did not detect any martens during the coastal survey, but documented fishers at 58% of the sample units (Table 2). During our montane survey in 2016, we detected one marten (2% of sample units) and no fishers (Table 2). The marten was detected near Mt. Olympus approximately 4 km from a marten detection obtained during fisher surveys in 2015. These locations were 44 km from the location of a photograph taken opportunistically by a mountaineer near Mt. Cruiser in 2015, which was just north of where the dead juvenile female was found in 2008 (Figures 2 and 3).

In addition to martens and fishers, we detected several species of local interest. Virginia opossums (*Didelphis virginiana*), a non-native species, may be immigrating into the Peninsula based on detections at one sample unit (Table 2). Coyotes (*Canis latrans*), mountain lions (*Puma concolor*), and bobcats (*Lynx rufus*), potential predators of both martens and fishers (Bull and Heater 2001, Gabriel et al. 2015), were detected frequently during the montane survey ($n = 23$ sample units), but less often during the coastal survey ($n = 3$ sample units; Table 2).

## Discussion

Based on all available evidence, including extensive surveys that we conducted from 2013 to 2016, Pacific martens appear to be very limited in distribution and at critically low numbers throughout most of their former range on the Olympic Peninsula in Washington. From 1968 to 2016, only nine reliable detections of martens are known from the Olympic Peninsula, including six obtained opportunistically from 1968 to 2008, two obtained in 2015 and 2016 during our surveys, and a photograph taken opportunistically in 2015 (Figures 2 and 3). All detections were obtained in remote, high-elevation areas; there is no recent evidence that martens have persisted at lower elevations where they were once the target of local trappers (Scheffer 1995). In addition, the two marten detections from our surveys were both in the upper Hoh River drainage near the northern base of Mt. Olympus, only 4 km distant, and obtained < 1 year apart; thus, they may have been the same individual. Conversely, the Mt. Cruiser detection occurred approximately 44 km from the Mt. Olympus detections, and likely represents a second individual.

Although we focused our high-density coastal survey in areas that contained habitat conditions similar to those martens occupy in coastal Oregon and California, we did not detect martens. Fisher monitoring surveys that were distributed more broadly and systematically throughout the coastal lowlands (Figure 3) also failed to detect martens. Although we cannot rule out the possibility that martens occur farther inland along the coast, it seems likely that remnant marten populations on the Olympic Peninsula are restricted to remote, high-elevation areas. It is unclear why martens appear to be absent from lower elevations on the Olympic Peninsula where they occurred historically, but we speculate that it may be related to extensive habitat modifications, especially from timber harvest. Complex forest structure provides martens with escape cover from predators (Drew 1995, Andruskiw et al. 2008); timber harvest typically simplifies forest structure, which increases predation risk for martens from larger-bodied, generalist predators such as bobcats, coyotes, and barred owls (*Strix varia*), which could limit marten distribution or abundance (e.g., Prugh et al. 2009, Ritchie and Johnson 2009, Wiens et al. 2014, Holm et al. 2016).

It is not clear how interspecific relationships between martens and fishers may have influenced historical distribution patterns of martens on the Peninsula. Historical records suggest that fishers and martens occurred sympatrically throughout low- to mid-elevation forests on the Olympic Peninsula (Dalquest 1948, Scheffer 1995), but how these species may have interacted or partitioned niches is unknown. Likely, martens avoid fishers spatially or temporally to reduce competition or predation (Thomasma 1996, Manlick et al. 2017, Zielinski et al. 2017). Fishers generally occur at low- to mid-elevations where deep snowpacks don't accumulate (Lofroth et al. 2010, Spencer et al. 2015). The lower foot loading of martens (Krohn et al. 2004) enables them to exploit high-elevation regions where snowpacks form in the western states, potentially reducing competition with fishers. Despite the influence of snow on habitat partitioning of fishers and martens in some regions (e.g., Manlick et al. 2017, Zielinski et al. 2017), both species occur in low-elevation coastal forests in California and Oregon that are characterized by dense shrubs year round (Klug 1997, Slauson et al. 2007, Thompson 2008, Moriarty et al. 2016, Moriarty et al. 2019). Complex communities can co-exist with ample food resources, and marten diets are broad in coastal environments (Slauson and Zielinski 2017, Eriksson et al. 2019, Manlick et al. 2019). Thus, available evidence indicates that both species once occupied low-elevation coastal forests on the Peninsula.

Martens may have been extirpated in low- to mid-elevation forests on the Olympic Peninsula by overtrapping, which adversely affected both marten and fisher populations throughout the western states (e.g., Dixon 1925, Dalquest 1948, Yocom and McCollum 1974). High-elevation forests on the Peninsula may have provided a refuge from trapping, due to their remoteness, relative inaccessibility, and protection in Olympic National Park and wilderness areas of Olympic National Forest. Although extensive modification of lower elevation forests does not appear to provide a barrier to movements by reintroduced fishers (Lewis et al. 2016), martens generally avoid young forests and, typically, do not cross openings > 50 m wide (Cushman et al. 2011, Moriarty et al. 2015). Avoidance of young forests, along with more limited dispersal capabilities compared to fishers, may provide a partial explanation for why martens have not recolonized lower elevation forests from higher elevation refuges.

A recent analysis of the phylogeographic relations of Pacific marten populations in Washington, Oregon, and California based on genetic data from > 400 modern and historical samples (Schwartz and Pilgrim 2016) revealed important new insights about the evolutionary history and current status of Olympic Peninsula martens. The analysis included seven genetic samples from the Olympic Peninsula: one modern specimen collected in 2008 on Mt. Rose (University of Washington Burke Museum, Seattle; UWBM 81064) and six historical specimens collected from 1886 to 1902 (National Museum of Natural History, Washington, D.C.; USNM 71289, 96579, 116656, 119965, 119977, 188219). Marten populations in the Pacific states formed two major clades: one that includes the Olympic Peninsula, Washington Cascades, Blue Mountains in Oregon, and Sierra Nevada in California, and a second that includes the Oregon Coast Range, California Coast Range, and Oregon Cascades (Schwartz and Pilgrim 2016). Thus, martens on the Olympic Peninsula do not belong to the same genetic clade as the coastal Pacific martens in Oregon and California (*M. c. humboldtensis*) that are currently of significant conservation concern (e.g., California Fish and Wildlife Commission 2018, Linnell et al. 2018, USFWS 2018). These findings demonstrate that the Columbia River impedes gene flow among marten populations in the Pacific states both in coastal areas and in the Cascade Range.

Historical and modern samples from the Olympic Peninsula grouped closely together and formed a reciprocally monophyletic subclade (Schwartz and Pilgrim 2016), confirming that current and historical marten populations on the Peninsula are comparable genetically, and that the Mt. Rose specimen is a remnant of the original populations and does not represent a dispersal event from another portion of the marten's range. In addition, samples from coastal Washington aligned genetically with those from the western portion of the Cascade Range in Washington, indicating that martens colonized the Olympic Peninsula from the Cascade Range. Thus, there may once have been greater connectivity between coastal and montane (Cascade) marten populations in Washington than there was between coastal and montane populations in Oregon and California. Accordingly, marten populations in the Cascade Range of Washington, which appear to be relatively abundant and well distributed (Zielinski et al. 2001), could provide a source population for the augmentation of Pacific marten populations on the Olympic Peninsula, should such actions be deemed appropriate by wildlife managers and conservationists (Manlick et al. 2016, Aylward et al. 2019, Grauer et al. 2019).

The scarcity and isolation of verifiable occurrence records for Pacific martens in both coastal and montane regions on the Olympic Peninsula suggests that the long-term persistence of this remnant population is at risk. We suspect that the Peninsula's geologic history and recent habitat modifications from forest management, urbanization, and agricultural land uses in the Puget Sound region and Chehalis River valley have contributed to the geographic isolation and decline in abundance of martens and other mammals (e.g., fishers) on the Peninsula. Potential risks to remnant marten populations include demographic effects associated with small population size and further reductions in the availability of suitable habitat. In montane environments, Pacific marten habitats are typified by deep snow cover in winter, where it has been hypothesized they find seasonal refugia from predators (Moriarty et al. 2015). Nonetheless, recent climate trends involving increased winter temperatures and decreased snowfall in western Washington could reduce available habitat and refugia at high elevations and further threaten the viability of montane marten populations (Dawson et al. 2011, Pauli et al. 2013), while increasing the extent of available habitat for fishers (Spencer et al. 2015, Halofsky et al. 2017, Suffice et al. 2017). Increased surveillance for martens involving more intensive and efficient survey methods, such as scent detection dog teams (Moriarty et al. 2018) or over-winter remote camera surveys, would help delineate other areas where martens still occur on the Olympic Peninsula. Further, surveys designed to collect additional genetic samples are essential for evaluating the genetic diversity and demographic characteristics of these potentially threatened marten populations.

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