

American Society of Mammalogists

Status of American Martens in Coastal Forests of the Pacific States

Author(s): William J. Zielinski, Keith M. Slauson, Carlos R. Carroll, Christopher J. Kent, Donald G. Kudrna

Source: *Journal of Mammalogy*, Vol. 82, No. 2 (May, 2001), pp. 478-490

Published by: American Society of Mammalogists

Stable URL: <http://www.jstor.org/stable/1383728>

Accessed: 15/07/2009 19:50

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=asm>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit organization founded in 1995 to build trusted digital archives for scholarship. We work with the scholarly community to preserve their work and the materials they rely upon, and to build a common research platform that promotes the discovery and use of these resources. For more information about JSTOR, please contact support@jstor.org.



American Society of Mammalogists is collaborating with JSTOR to digitize, preserve and extend access to *Journal of Mammalogy*.

<http://www.jstor.org>

STATUS OF AMERICAN MARTENS IN COASTAL FORESTS OF THE PACIFIC STATES

WILLIAM J. ZIELINSKI,* KEITH M. SLAUSON, CARLOS R. CARROLL, CHRISTOPHER J. KENT, AND DONALD G. KUDRNA

Redwood Sciences Laboratory, Pacific Southwest Research Station, United States Forest Service, 1700 Bayview Drive, Arcata, CA 95521 (WJZ, KMS)

Conservation Biology Institute, 800 NW Starker Avenue, Suite 31C, Corvallis, OR 97330 (CRC)

Six Rivers National Forest, United States Forest Service, 1330 Bayshore Way, Eureka, CA 95501 (CJK, DGK)

Present Address of CRC: Klamath Center for Conservation Research, P.O. Box 104, Orleans, CA 95556

American martens (*Martes americana*) are associated strongly with mature conifer forests and once occurred throughout the mountains of the coastal Pacific states. We sought to document the distribution of martens in this region using historical records and to understand recent change in their distribution. We described the distribution of martens from 1900 to 1949 using museum and trapping records and compared it to recent (1989–1998) detections at camera and track-plate stations. Martens were detected at only 12 of the 237 (5.1%) survey sample units in coastal California, Oregon, and Washington. Martens are absent from most of the historical range of the Humboldt marten (*M. a. humboldtensis*) in California and also may have declined on the Olympic Peninsula of Washington. Few data exist from northwestern Oregon and southwestern Washington, but the limited amount of protected public land and absence of reported road kills are reasons for concern for populations in this region. Martens still occur in the central and southern coastal mountains of Oregon. Our results suggest that conservation of martens in coastal forests will require new initiatives to protect existing populations and new efforts to document all populations of martens in this region. Conservation measures should include a reevaluation of timber harvest plans that affect habitat in coastal forests, interagency cooperation on a coastal marten conservation assessment, and the collection of new survey information, especially on private lands in southwestern Washington and northwestern Oregon.

Key words: conservation, distribution, marten, *Martes americana*, Pacific states

American martens (*Martes americana*) once occurred throughout the coastal forests of northern California, Oregon, Washington, British Columbia, and Alaska (Hall 1981). The species is typically associated with late-seral coniferous forests characterized by closed canopies, large trees, and abundant standing and down woody material (Buskirk and Powell 1994; Thompson

and Harestad 1994). Coastal Pacific forests are extremely productive and include some of the most valuable trees in the world. The relatively easy access by ocean to this resource resulted in heavy exploitation of the region early in the period of European settlement (United States Department of Agriculture 1992). Because much of the coastal forest region is in private ownership, the focus on timber production continues. Although the status of American martens was

* Correspondent: bzielinski@fs.fed.us

considered during the planning process for restoring late-successional habitat within the range of the northern spotted owl (*Strix occidentalis caurina*) on federal lands (Northwest Forest Plan—United States Department of Agriculture 1993), this was largely a summary of professional opinion and did not include significant review of existing data or collection of new data. However, the marten was judged the 2nd-least likely mammal species to remain well distributed within the range of the northern spotted owl in Washington, Oregon, and California under the preferred alternative (United States Department of Agriculture 1993).

Three subspecies of *M. americana* occur in the coastal or near-coastal regions of the Pacific Northwest. In California, the range of *M. a. humboldtensis* includes the northwestern coast from the Oregon–California boundary south to Sonoma County (Grinnell and Dixon 1926; Grinnell et al. 1937; Fig. 1A). The Humboldt subspecies is replaced at the northern boundary of the range of coast redwoods (*Sequoia sempervirens*) by *M. a. caurina*, which continues along the coast north to British Columbia (Merriam 1890; Miller 1912; Wright 1953; Fig. 1A). *M. a. sierrae* (Grinnell et al. 1937) occurs nearest the coast in the Trinity Mountains in northwestern California and then east to the Cascades and south throughout the Sierra Nevada.

Of the coastal subspecies, *M. a. humboldtensis* has attracted the greatest conservation concern (Kucera et al. 1995; Zielinski and Golightly 1996). Originally, the Humboldt marten occurred from sea level to about 3,000 feet in the “narrow northwest humid coast strip, chiefly within the redwood belt” (Grinnell et al. 1937:209). Grinnell et al. (1937) related accounts of individual trappers taking 35 and 50 martens in 1 winter within a few miles of the coast. Declining harvests led to the closure of the season in extreme northwestern California in 1946. Zielinski and Golightly (1996) could not document a single verified

location within the historical range of *M. a. humboldtensis* in the 50 years prior to 1995. The subspecies was assumed to be either very rare or extinct.

Martes a. sierrae, which occurs in the Sierra Nevada of California, and *M. a. caurina*, which occurs in coastal Oregon, Washington, and British Columbia and the Cascades, have apparently never become as uncommon as the Humboldt marten. Although trapping of the Sierran subspecies was prohibited in 1954, it has remained well distributed over most of its historical range (Grinnell et al. 1937; Kucera et al. 1995; Schmepf and White 1977). At the time of European settlement, *M. a. caurina* occurred throughout coastal forests of Oregon and Washington, including locations at sea level (Bailey 1936; Hagmeier 1956). However, previous reviews indicate that martens appear to be absent from the coastal forests of northern Oregon and southern Washington and rare on the Olympic Peninsula (Dalquest 1948; Gibilisco 1994; R. E. Johnson and K. M. Cassidy, in litt.; D. B. Marshall, in litt.; Sheets 1993; Verts and Carraway 1998). Martens are still legally trapped in coastal Oregon and Washington, although the season has been closed intermittently for various periods since the 1930s (L. Cooper, pers. comm.; Martinsen 1971; Rhymon 1969).

Comparing the historical distribution of a species to its current distribution is the 1st step toward determining its status. We conducted an assessment of martens in the coastal mountains of the Pacific states. We summarized the current status of the coastal subspecies and report new survey results. We build on reviews of other western subspecies of martens (Kucera et al. 1995; D. B. Marshall, in litt.; Sheets 1993; Verts and Carraway 1998; Zielinski and Golightly 1996) and consider together the status of *M. a. humboldtensis* and *M. a. caurina* across their ranges in California, Oregon, and Washington.

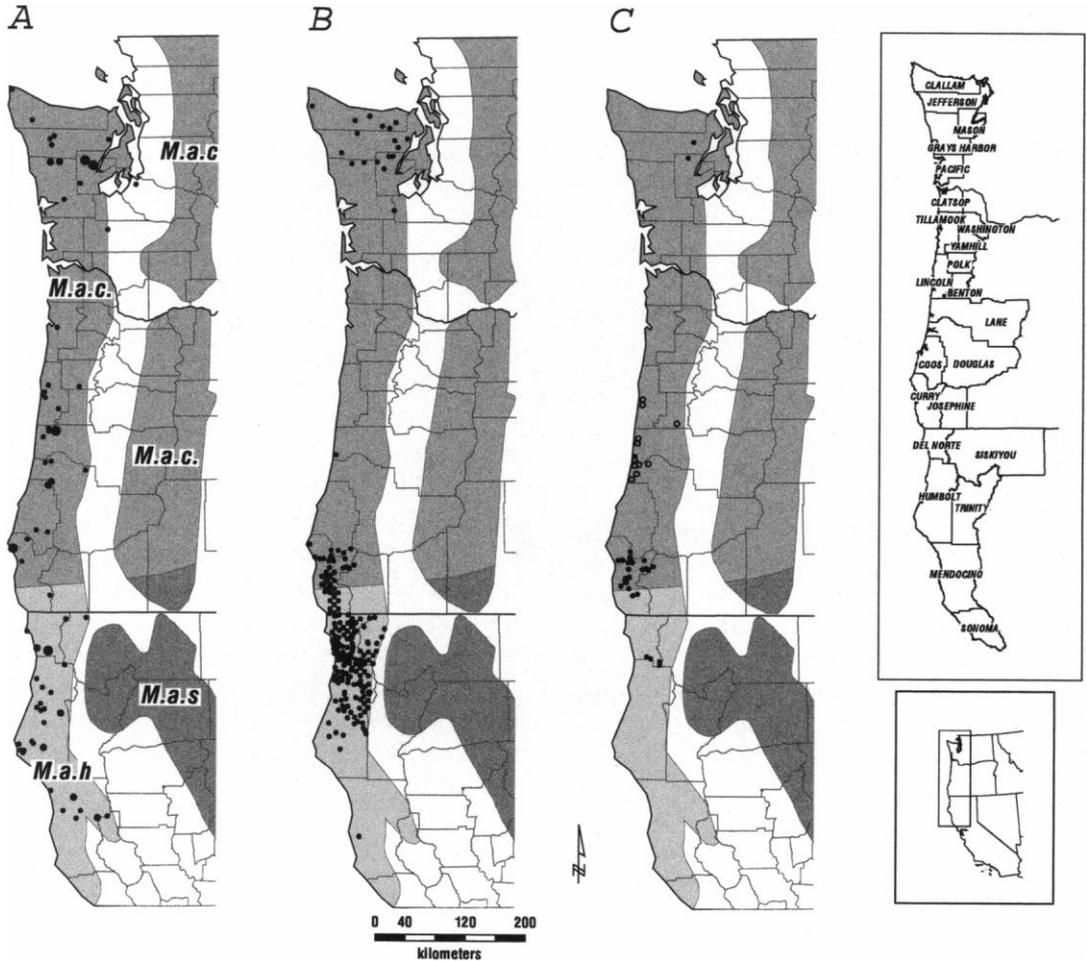


FIG. 1.—A) Historical distribution of *Martes americana humboldtensis* and *M. a. caurina* in California, Oregon, and Washington based on records collected during the early and mid-20th century. Size of circles is proportional to the number of records from the location; smallest = 1 and largest = 5–10. B) Centers of track-plate and camera sample units (see text for definition) from 1989 to 1998. C) Contemporary distribution of martens from track-plate, camera, and snow-tracking surveys (solid circles) and road kills or trapped animals (open circles) from 1989 to 1998. Subspecific boundaries are adapted from the integration of ranges presented in Dalquest (1948), Hagmeier (1956), and Hall (1981).

METHODS

Historical Information

We reviewed all available published and unpublished information on *M. a. humboldtensis* and *M. a. caurina*, which included previous reviews (Bailey 1936; Dalquest 1948; Gibilisco 1994; Grinnell et al. 1937; Kucera et al. 1995; D. B. Marshall, in litt.; Maser et al. 1981; Olterman and Verts 1972; Schempf and White

1977; Sheets 1993; Verts and Carraway 1998; Yocum 1974; Zielinski and Golightly 1996), selected files of sightings records from state and federal resource management agencies, and unpublished field notes of agency biologists and fur trappers. We also interviewed individuals who could provide special perspective on the history and current status of martens, including biologists employed by agencies or timber companies, representatives of Native American

tribes, outdoorsmen, and trappers. Information that could not be verified was not included in our database of geographic locations but provided important background information. Most of the historical data used for this analysis came from requests sent to 23 museums in North America for information about *M. a. humboldtensis* or *M. a. caurina* in their collections.

Contemporary Information

Field surveys.—We summarized 4 types of surveys, conducted from 1989 to 1998, using sooted track plates and remotely operated cameras, which are effective in detecting many forest carnivores, including American martens (Raphael 1994; Zielinski and Kucera 1995). We did not use reported sightings because we doubted the ability of many observers to distinguish martens from other species. Administrative surveys are often recommended as part of biologic evaluations preceding land management activities (e.g., timber harvest). Surveys conducted by research organizations were of 2 types: road based and systematic. In the former, track plates or cameras were placed at regular intervals along roads (K. M. Beyer and R. T. Golightly, in litt.; L. L. C. Jones and M. G. Raphael, in litt.; Sheets 1993). In the latter, track plates or cameras were placed at regular intervals throughout the forest in the Klamath region of California and Oregon (Carroll et al. 1999). Follow-up surveys were established at the locations of highly reliable sightings or at locations where a single track or photograph detection had occurred. All surveys used either chicken, fish, deer, or elk as bait. The only stations that used commercial trapping lure (Mountain Marten® and Skunk-it®, M&M Fur Company, Bridgewater, South Dakota, or Gusto®, Minnesota Trapline Products, Pennock) as an attractant were systematic research surveys in the Klamath region (only at stations that did not receive either a marten or fisher detection by the 4th visit) and the few follow-up surveys near the Klamath sample units in California.

We summarized the data represented by the 4 types of surveys by adopting the use of a standard sample unit. A sample unit is a collection of ≥ 4 track-plate stations or line-triggered camera stations or ≥ 2 35-mm camera stations deployed simultaneously. Those methods were viewed as equivalent because the track-plate and line-triggered stations tend to be run for one-half the duration of the 35-mm cameras. Sample

units had multiple stations, and the number of stations differed among sample units. However, each sample unit was recorded as detecting presence when a marten was detected at any 1 of the stations. A minimum of 6.4 km was required between the closest stations of each unit. Similarly, if >1 survey occurred in the same general location, they were considered independent only if the intersurvey interval exceeded 1 year.

Administrative surveys used either track plates, line-triggered cameras, or 35-mm camera (usually Trailmaster Model 1500 or 500; Goodson and Assoc., Inc., Lenexa, Kansas) stations (4–50 stations/sample unit) that were distributed at about 0.8-km intervals along forest roads in a project area (Zielinski 1992; Zielinski and Kucera 1995). Those surveys were conducted for a minimum of 8 days, except for the 35-mm cameras, which were run for ≥ 30 days. All administrative surveys were conducted in California and Oregon in 1989–1995.

The road-based research surveys included surveys exclusively within the redwood region in California (K. M. Beyer and R. T. Golightly, in litt.) and the predominately line-triggered camera surveys in Washington conducted by L. L. C. Jones and M. G. Raphael (in litt.) and Sheets (1993). Surveys in the redwood region were conducted in 1994 and included 48 sample units, each composed of 6 track-plate stations set at 1-km intervals along roads. Each station was checked every other day for 22 days. The road-based research surveys in Washington included 18 sample units and were conducted in 1990–1992; each sample unit was composed of multiple line-triggered camera stations (and a few track plates in 1990) placed about 1.0 km apart along roadsides and checked every other day for ≥ 8 days (L. L. C. Jones and M. G. Raphael, in litt.).

The systematic research surveys in the Klamath region were conducted during the summers of 1996 and 1997 and included 78 sample units. A sample unit was a circle of 5 track-plate stations, each 0.5 km from a 6th station in the center, which was 7–10 km from the center of adjacent sample units ($n = 468$ stations). Nineteen of the units (114 stations) were in Oregon and 59 units (354 stations) in California. Track plates were checked every 2 days for 16 days. Follow-up surveys used 35-mm cameras ($n = 13$ sample units; 26 stations) or track plates ($n = 5$ sample units; 38 stations) and were near the locations in

California where the Klamath research surveys detected martens. Those surveys used 10.4-km² blocks with either 2 35-mm camera stations or 6 track-plate stations checked for a minimum of 28 and 16 days, respectively.

A few snow-tracking surveys were conducted on the Siskiyou National Forest in Oregon. Where these detected *Martes* tracks outside the known geographic range of fishers, they were included as part of the contemporary record. We were unable to obtain information about the effort or locations of snow surveys in which no tracks were discovered.

Habitat information at detection locations.—We collected vegetation information at all the sample units in the Klamath research surveys and for the follow-up surveys in California at those locations where martens were detected. We used the California Wildlife Habitat Relations (CWHR) system (Mayer and Laudenslayer 1988) to describe the cover type near each location as 1 of 5 tree size classes (class 2 = 2.5–15.2 cm dbh [diameter breast height], 3 = 15.3–27.9 cm dbh, 4 = 28.0–61.0 cm dbh, 5 = >61.1 cm dbh, 6 = class 5 + multiple layers) and 1 of 3 canopy closure classes (sparse–open = 10–39%, moderate = 40–59%, dense = 60–100%). Each track plate also was the center of a variable-radius plot where we used prism sampling (Wenger 1984) to estimate basal area of all trees and snags. We recorded the species, dbh (1.4 m), height, and condition class of each tree in the sample and estimated the number of logs and the canopy closure using 2 perpendicular, 25-m transects centered on the track plate. Logs that intersected the transect were tallied into 4 maximum-diameter categories (15–30, 31–60, 61–90, and >90 cm). At the track plate and at the 4 cardinal directions at the 4 transect termini, we measured total canopy closure using a densitometer. We estimated the percentage cover of the dominant tree and shrub species by eye calibration.

RESULTS

Historical Information

Twenty-three museums (100%) responded, and 4 reported a total of 22 specimens of *M. a. humboldtensis*, all dated before 1928. Five reported a total of 90 specimens of *M. a. caurina*, with various dates from 1886 to 1983. The historical summary (Fig.

1A) included records from primary museum specimens (62%) and secondary records (38%). The latter include locations published in early accounts (Bailey 1936; Grinnell et al. 1937; Olterman and Verts 1972) and derived from trapper interviews (e.g., Grinnell et al. 1937; Hemphill 1952; Twinning and Hensley 1947). All historical records from Washington were primary records, and two-thirds of the records from Oregon and about one-third of the historical locations for California were primary records.

California.—Few records of Humboldt martens are reported from California in the last 60 years. In 1942, 8 trappers in coastal Humboldt and Del Norte counties caught an average of 2 martens, and Twinning and Hensley (1947) concluded that the range in northwestern California had contracted. In the late 1940s, Hemphill (1952) estimated >100 martens on the Mendocino National Forest, although no data were provided. Yocum (1974) reported 7 incidental observations by biologists from 1961 to 1972. Wildlife files of government agencies included 9 observations of Humboldt martens from 1960 to 1975 (Schempf and White 1977). Raphael and Barrett (1981) collected tracks at 135 sooted track-plate stations on the eastern margin of the range of the Humboldt marten, but martens could not be confirmed among them (Raphael 1988). Three tanned skins trapped in the 1940s near Smith River, California (J. Hight, pers. comm.), represented the most recent historical record of martens within the range of *M. a. humboldtensis*. Interviews of biologists, foresters, and trappers in northwestern California did not result in any evidence of verifiable sightings or road kills.

Oregon.—The number of martens harvested in coastal Oregon counties has declined since the 1940s (Fig. 2), most notably in Coos and Curry counties. Caution must be exercised in interpreting trapping data because of annual variation in trapper effort and pelt prices; however, a large increase in the price paid for pelts occurred

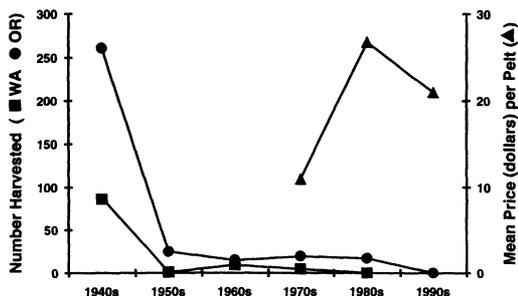


FIG. 2.—Number of martens trapped, by decade, in the predominantly coastal counties of Washington (Clallam, Grays Harbor, Jefferson, Kitsap, Mason, Pacific) and Oregon (Benton, Clatsop, Columbia, Coos, Curry, Josephine, Lincoln, Polk, Tillamook, Washington, Yamhill) and the mean price paid for each pelt.

in the late 1980s with no corresponding increase in harvest for any of the coastal counties (Fig. 2; Verts and Carraway 1998). Sherrell (1970) interviewed trappers in Curry County in the early 1900s and reported several localities where martens were once common but were now rare. By the 1970s martens were considered very rare along the Oregon coast (Mace 1970; Maser et al. 1981). Although historical records are sparse in the northern coastal Oregon counties (Fig. 1A), early trapping records, reported only at the county level, verify occurrence of martens in the northern Oregon counties of Clatsop, Tillamook, Washington, and Yamhill (Anonymous 1914; C. Bruce, pers. comm.; L. Cooper, pers. comm.; D. B. Marshall, in litt.; Verts and Carraway 1998).

Washington.—The historical range of martens in Washington includes all coastal counties (D. B. Marshall, in litt.; Sheets 1993). The harvest of martens in coastal Washington has never been consistent (Fig. 2). Notable was the largest harvest for any decade from the Olympic Mountains in the 1940s, 83 animals from Clallam, Jefferson, and Mason counties. Martens once occurred along the Washington coast to sea level, and Dalquest (1948) suspected that the species still might have occurred in the Willapa

Hills in the 1940s. Only a few records exist of martens harvested from the southwestern counties (including martens trapped in the early 1900s in Pacific County; B. Adamire, pers. comm.), and martens are presumed to have been extirpated from this area of Washington (Gibilisco 1994; D. B. Marshall, in litt.; Sheets 1993). In addition to trapping, martens in the Olympic Mountains also were killed by poisons intended for large carnivores (B. Adamire, pers. comm.).

Contemporary Surveys

Survey effort.—Since 1989, a total of 237 sample units, using about 2,360 track-plate or camera stations comprising about 34,800 survey days, were sampled in the coastal mountains of California, Oregon, and Washington (Table 1; Fig. 1B). The density and distribution of surveys were much greater in California than in the other states, but surveys in California favored the northern portion of the historical range of the Humboldt marten over the southern portion (Mendocino and Sonoma counties). Surveys in California included a much larger sample of private land than in Oregon and Washington, where surveys occurred almost exclusively on federal land (Fig. 3). All 35 surveys in Oregon were conducted in either the Siskiyou (34) or Siuslaw (1) National Forests. Surveys in Oregon and Washington were road-based research surveys or administrative surveys (except for a minority of the sample units in Oregon from the Klamath research survey), whereas all 4 types of surveys were conducted in California. We are unaware of any survey that met our minimum requirements for inclusion that was conducted in northwestern Oregon or the southwestern Washington coastal mountains.

Detections.—Martens were detected at 12 of the 237 (5.1%) sample units across all 3 states. Martens were detected at 4 of 184 (2.2%) sample units in California. All 16 detections at these 4 units were clustered in an area <200 km² in southern Del Norte

TABLE 1.—Number and type of sample units and stations to survey martens (see Methods) by state, 1985–1998.

	Administrative	Research, road based	Research, systematic	Follow-up	Total
California					
Sample units	69	48	59	8	184
Stations	768	500	354	65	1,687
Oregon					
Sample units	13		19	3	35
Stations	98		114	18	230
Washington					
Sample units		18			18
Stations		443			443
Total					
Sample units	82	66	78	11	237
Stations	866	1,443	468	83	2,360
Survey days	17,196	8,544	7,488	1,560	34,792

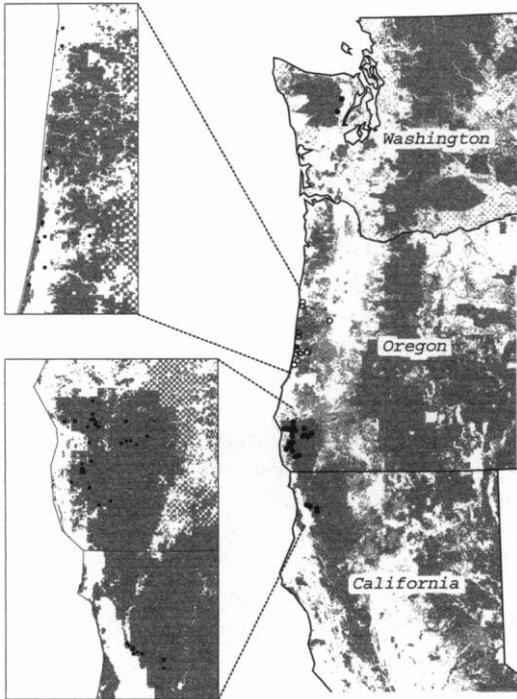


FIG. 3.—Contemporary (1989–1998) detections of martens on federal and state public land (shaded) and private land. Detailed views depict actual locations where martens were detected rather than centers of sample units.

County on the Six Rivers National Forest near the southern end of the Siskiyou Wilderness (Fig. 1C). The 1st (1996) and 2nd (1997) detections occurred during the Klamath systematic research surveys. The remainder were from follow-up surveys in 1998 and 1999 conducted within a 15-km radius of the initial detections. No road kills have been reported in coastal California. The 16 detections near the Siskiyou Wilderness, which probably reflected fewer individuals, represented the only known population of martens in the Coast Range of California.

Surveys in Oregon detected martens at 6 of 35 (17.1%) sample units (Fig. 1C) that excluded detections by snow-track survey. Much of the contemporary location information in central Oregon (1980–1998) was derived from road kills, 9 on the Highway 101 corridor in the Siuslaw National Forest and Oregon Dune National Recreation Area and 1 on a national forest road. Most detections of martens in Oregon were on public lands in the central and southern portions of the Oregon Coast Range (Fig. 1C).

In Washington, martens were detected in only 2 of 18 sample units (11.1%) and only at a single station within each unit. All but 1 sample unit were in the Olympic National

TABLE 2.—Distribution detection locations of martens among the California Wildlife Habitat Relationships (CWHR) system cover types, tree size classes, and canopy closure classes (percentages of detections in parentheses); all assessments are visual estimates.

Cover type		Tree size class ^a		Canopy closure class ^b	
Class	No. marten detections	Class	No. marten detections	Class	No. marten detections
Douglas fir	9 (33.3)	Class 2	4 (14.8)	Sparse–open	2 (7.4)
Mixed hardwood and conifer	7 (25.9)	Class 3	7 (25.9)	Moderate	4 (14.8)
Lodgepole pine	4 (14.8)	Class 4	7 (25.9)	Dense	21 (77.8)
Montane chaparral	1 (3.7)	Class 5	8 (29.6)		
Jeffrey pine	1 (3.7)	Class 6	1 (3.7)		
Montane hardwood	1 (3.7)				
Klamath mixed conifer	1 (3.7)				
Unknown	3 (11.1)				

^a Class 2 = 2.5–15.2 cm dbh (diameter breast height); class 3 = 15.3–27.9 cm dbh; class 4 = 28.0–61.0 cm dbh; class 5 = >61.1 cm dbh; class 6 = class 5 + multiple layers.

^b Sparse–open = 0–39%; moderate = 40–59%; dense = 60–100%.

Park or Olympic National Forest. No surveys occurred in the central or southern portions of the coastal mountains. No road kills have been reported for coastal areas in Washington. The few summary data from Washington suggest that martens still occur on the eastern Olympic Peninsula.

The contrast between historical and contemporary distributions of martens is especially clear in California, where surveys have been numerous but detections few. Data are too few elsewhere to make similar statements, but absence of detections of martens in the western Olympic Peninsula suggests that their range in northwestern Washington also may have contracted. Martens currently occupy west-central and extreme southwestern Oregon. Unfortunately, the northern Oregon and southern Washington coastal mountains were not well represented in either historical records or the recent survey effort, making it difficult to assess the status of martens there.

Habitat at detection locations.—The stations in California and southern Oregon where martens were detected ($n = 27$) were represented by 7 different CWHR cover types (Table 2). Douglas fir (*Pseudotsuga menziesii*) was the most common type, but detections also occurred in a montane hardwood and a montane chaparral type. The

detection locations were distributed evenly across 3 of 5 tree size classes but were most often in the dense (60–100%) overhead canopy closure class (Table 3). One of the most distinguishing characteristics of the detection locations was the density of shrubs, such as salal (*Gaultheria shallon*), Pacific rhododendron (*Rhododendron macrophyllum*), and huckleberry oak (*Quercus vaccinifolia*). Mean shrub cover was 70.5% \pm 16.5 SD, with a paucity of logs >15 cm diameter ($\bar{X} = 1.7/\text{site}$) and large logs >90 cm (0.03/site) and a wide range (0–97.8%; $\bar{X} = 69.6\%$) of average canopy closure readings (Table 3). Nine of 29 detections occurred on serpentine soils on ridges where the basal area of trees was very low (minimum = 9.24 m²/ha) but where shrub density was high. The southernmost locations, on the Six Rivers National Forest, tended to have the higher values for total basal area and overstory canopy closure.

DISCUSSION

Martens are considered the most abundant of the 4 forest carnivores, which include the fisher (*Martes pennanti*), wolverine (*Gulo gulo*), and lynx (*Lynx canadensis*). Although their continental range may have declined (Gibilisco 1994), populations of martens have not suffered the magnitude

TABLE 3.—Vegetation and topographic characteristics at locations in California and Oregon where martens were detected ($n = 29$ except for shrub and herb cover, for which $n = 12$).

Character	Range	\bar{X}	SD	95% CI
Basal area (BA)	9.24–78.54	40.94	19.47	33.54–48.35
BA, conifer	0–69.30	30.75	19.84	23.20–38.29
BA, hardwood	0–69.30	10.20	17.13	3.68–16.71
Mean diameter breast height (dbh)	7.80–119.50	39.82	26.28	29.82–49.81
Quadratic mean dbh	8.30–122.00	43.38	27.64	32.87–53.90
Mean height	4.00–44.90	19.79	11.76	15.32–24.26
Mean dbh, conifer	0–119.50	42.39	30.18	30.91–53.87
Mean dbh, hardwood	0–48.00	13.21	15.93	7.15–19.26
Mean, canopy closure (%)	0–97.80	69.64	29.72	58.34–80.94
Percent shrub cover (%)	28.60–90.60	70.52	16.53	60.02–81.03
Mean herb cover (%)	0–51.00	13.83	20.56	0.77–26.90
Number of logs	0–10.00	1.69	2.24	0.84–2.54
Number of large logs	0–1.00	0.03	0.19	0–0.11
Slope (%)	0–65.00	30.38	18.34	23.40–37.35

of decrease in the 20th century that has characterized the other species (Ruggiero et al. 1994). Martens are still legally trapped for their fur in most of the western states. Although individuals are affected by habitat loss, habitat fragmentation, and direct mortality via trapping (Bissonette et al. 1997; Hargis et al. 1999), most of the 14 subspecies appear to be well distributed within their geographic ranges. Exceptions include *M. a. atrata* on Newfoundland (Burnett et al. 1989), *M. a. americana* in portions of eastern Canada (Thompson 1991), and, based on our data, *M. a. humboldtensis*. Our survey results should be cause for concern about the persistence of *M. a. humboldtensis*. Data do not support a similar level of concern for *M. a. caurina* on the Olympic Peninsula, but our results support the conclusions of others (D. B. Marshall, in litt.; Sheets 1993) that martens have declined there. Our documentation of the loss of martens from significant portions of their historical range in the coastal forests contrasts with their status in the interior forests of the Cascades, Sierra Nevada, and Rocky Mountains (Gibilisco 1994; Kucera et al. 1995).

We did not uncover sufficient historical or contemporary data to allow us to eval-

uate the status of martens in the coastal mountain ranges of central and northern Oregon and southern Washington. The routes taken by early (1800s) museum expeditions bypassed most of this region (Verts and Carraway 1998), and we found few museum records from this era. However, martens are included in the earliest records of commercial fur harvest in the central and northern coastal counties of Oregon (Anonymous 1914; C. Bruce, pers. comm.; L. Cooper, pers. comm.). Because much of the unsurveyed area between central Oregon and southern Washington is privately owned commercial forest or managed state forest (Fig. 3) on which very little mature or old-growth forest remains, we are not optimistic about the abundance of martens there. Martens are sensitive to forest fragmentation in both the Rocky Mountains (Bissonette et al. 1997; Hargis et al. 1999) and the northeastern United States (Bissonette et al. 1997; Chapin et al. 1998) and may respond similarly to fragmentation of mature forest habitat in coastal Oregon and Washington.

The absence of reported road kills along coastal Highway 101 in northern Oregon and southern Washington, in contrast to the dozen or so on the same highway in central

Oregon, also suggests low numbers of martens. Because this highway runs the entire length of the range of coastal martens in the Pacific states, densities of road kills should reflect the abundance of martens. Although not all evidence is as convincing as the results of detection surveys, the data suggest that of the 3 states, martens are most common in coastal Oregon.

In early 1996, the prognosis for the discovery and recovery of populations of martens in coastal California was bleak. The existence of martens within the historical range of the Humboldt subspecies was in doubt (Zielinski and Golightly 1996). Then, in 1996 and 1997, the detection of martens at 2 locations within the historical range of the Humboldt subspecies represented the 1st verified presence of martens in this region in 50 years. However, their location alone is insufficient evidence to conclude that they are members of *M. a. humboldtensis*. None of the animals we detected have been captured and examined, nor have we collected hair or other tissue for analysis. Furthermore, all detections occurred <100 km from the western boundary of *M. a. sierrae* (Grinnell et al. 1937). Also, none of the recent detections in California occurred in redwoods, the forest type with which the Humboldt marten was originally associated (Grinnell and Dixon 1926; Grinnell et al. 1937).

The ambiguity of the original subspecific boundaries and absence of genetic data make it difficult to assign the martens we detected in California to subspecies. Yet, from a conservation perspective, the subspecific affinity of the individual animals is academic; our results document the 1st martens detected within the California Coast Range since the trapping season was closed in 1946. It appears that a population of martens exists within the California coastal mountains, and with sufficient potential for growth to warrant conservation measures. Martens appear to occupy a region of about 150–200 km².

The demise of the Humboldt marten was

first attributed to overtrapping (Twining and Hensley 1947). However, it has been >50 years since martens have been protected from trapping in northwestern California. We believe that the effect of timber harvest in the redwood region is the most plausible reason for the continued absence of martens from most of the coastal range. The north coast was 1 of the 1st regions subjected to commercial harvest in California. Less than 5% of the original forest cover in the redwood region remains unharvested (Fox 1996). Because martens typically are associated with old forests with a diversity of large structural features (Buskirk and Powell 1994), it is likely that the intensity of timber harvest, especially on private land, has reduced the habitat value over much of the region and may affect immigration of martens to California from populations on public forest land in southwestern Oregon.

Tree basal area and canopy closure at detection locations varied considerably, but martens were almost always detected in dense shrub layer. In this respect, the habitat at marten detection locations resembles that described for the sable (*M. zibellina*) in China (Buskirk et al. 1996). Martens were detected at some locations with very few mature trees, where our previous understanding of the ecology of martens would have suggested that we would be unlikely to detect them. Many of those locations were on ridgetops where serpentine parent material limited density of trees but not shrubs. Detections were distributed quite evenly among size classes of CWHR trees, indicating that size class alone is not sufficient to predict presence of martens. In fact, the average basal area reported here (40.9 m²/ha) is lower than that reported at track-plate detection locations in the northern (Spencer 1981) and southern (W. J. Zielinski, in litt.) Sierra Nevada in California. However, most detection locations were in the CWHR dense class, consistent with the general description of the habitat of martens (Buskirk and Powell 1994). Canopy closure readings measured directly with a densi-

tometer also support the CWHR visual density estimates.

Our study draws attention to potential problems associated with managing a species associated with mature forest conditions in the coastal regions of the Pacific states. All martens detected were on or near public lands (Fig. 3). Detections are clumped in 4 locations, separated by significant distances. Although surveys on private lands in Oregon and Washington have not been conducted, based on the negative results of surveys on private lands in California, we suspect that martens are faring worse on private than public lands. Federal lands in the coastal mountains of the Pacific states are few and fragmented compared with the nearly continuous distribution of national forest and national park land in the Cascades and the Sierra Nevada (Fig. 3).

Our summary of historical information and results of recent detection surveys have emphasized *M. a. humboldtensis*, largely because of the concern about its continued existence (Zielinski and Golightly 1996). More historical and contemporary data exist on the distribution of *M. a. humboldtensis* in California than *M. a. caurina* in Oregon and Washington. However, conservation efforts should focus on all martens in coastal forests throughout the Pacific Northwest. Coastal forest habitats are poorly connected compared with inland habitats (e.g., Cascades, Sierra Nevada) that constitute most of the range of the species in the Pacific states. Our surveys have demonstrated a serious conservation problem that appears to affect populations and subspecies and that requires prompt attention if martens are to persist in forest communities of the Pacific coast.

ACKNOWLEDGMENTS

Many people helped collect the field data we synthesized, especially the employees of the United States Forest Service in Oregon and California. In particular we acknowledge the field assistance of T. Kirk, J. Lowe, D. Barrett, R. Brening, J. Shamansky, S. Paghluigi, and A.

Hill. C. Ogan, B. Devlin, T. Hacking, D. Austin, K. Schmidt, and S. Sniado, all of the Forest Service, provided essential administrative support and coordination for surveys. We thank D. Macfarlane of the Pacific Southwest Region of the United States Forest Service and A. Brickey of the United States Fish and Wildlife Service for providing funding. The Pacific Southwest Research Station of the Forest Service also provided financial support. We are indebted to L. Cooper and C. Bruce of the Oregon Department of Fish and Wildlife and J. Lewis of the Washington Department of Fish and Wildlife for providing information regarding the history of marten distribution. R. Truex assisted with analyses and review, and A. Wright created the maps. K. Aubry provided information about martens in Oregon and Washington and reviewed the manuscript. M. Raphael and S. Buskirk also provided helpful editorial comments, and A. Albert provided editorial assistance.

LITERATURE CITED

- ANONYMOUS. 1914. Report of fur-bearing animals. The Oregon Sportsman 2:20.
- BAILEY, V. 1936. The mammals and life zones of Oregon. North America Fauna 55:281-285.
- BISSONETTE, J. A., D. J. HARRISON, C. D. HARGIS, AND T. G. CHAPIN. 1997. The influence of spatial scale and scale-sensitive properties on habitat selection by American marten. Pp. 368-385 in Wildlife and landscape ecology (J. A. Bissonette, ed.). Springer-Verlag, New York.
- BURNETT, J. A., C. T. DAUPHINE, S. H. MCCRINDLE, AND T. MOSQUIN. 1989. On the brink: endangered species in Canada. Western Producer Prairie Books, Saskatoon, Saskatchewan, Canada.
- BUSKIRK, S. W., Y. MA, L. XU, AND Z. JIANG. 1996. Diets of, and prey selection by sables (*Martes zibellina*) in northern China. Journal of Mammalogy 77:725-730.
- BUSKIRK, S. W., AND R. A. POWELL. 1994. Habitat ecology of fishers and American martens. Pp. 283-296 in Martens, sables, and fishers (S. W. Buskirk, A. Harestad, M. Raphael, and R. A. Powell, eds.). Comstock Publishing Associates, Cornell University Press, Ithaca, New York.
- CARROLL, C., W. J. ZIELINSKI, AND R. F. NOSS. 1999. Using presence-absence data to build and test spatial habitat models for the fisher in the Klamath Region, U.S.A. Conservation Biology 13:1344-1359.
- CHAPIN, T. G., D. J. HARRISON, AND D. D. KATNIK. 1998. Influence of landscape pattern on habitat use by American marten in an industrial forest. Conservation Biology 12:1327-1337.
- DALQUEST, W. W. 1948. Mammals of Washington. University of Kansas Publications, Museum of Natural History 2:1-444.
- FOX, L., III. 1996. Current status and distribution of coast redwood. Pp. 18-20 in Proceedings of the

- Conference on Coast Redwood Forest Ecology and Management, June 18–20 (J. LeBlanc, ed.). Humboldt State University, Arcata, California.
- GIBILISCO, C. J. 1994. Distributional dynamics of modern Martes in North America. Pp. 59–71 in Martens, sables, and fishers (S. W. Buskirk, A. Harestad, M. Raphael, and R. A. Powell, eds.). Comstock Publishing Associates, Cornell University Press, Ithaca, New York.
- GRINNELL, J., AND J. DIXON. 1926. Two new races of the pine marten from the Pacific Coast of North America. *Zoology* 21:411–417.
- GRINNELL, J., J. S. DIXON, AND J. M. LINDSALE. 1937. Fur-bearing mammals of California. Vol. 1. University of California Press, Berkeley.
- HAGMEIER, E. M. 1956. Distribution of marten and fisher in North America. *The Canadian Field-Naturalist* 70:148–168.
- HALL, E. R. 1981. The mammals of North America. 2nd ed. John Wiley & Sons, New York 2:981–985.
- HARGIS, C. D., J. A. BISSONETTE, AND D. L. TURNER. 1999. The influence of forest fragmentation and landscape pattern on American martens. *The Journal of Applied Ecology* 36:157–172.
- HEMPHILL, D. V. 1952. The vertebrate fauna of the boreal areas of the southern Yolla Bolly mountains, California. Ph.D. dissertation, Oregon State College, Corvallis.
- KUCERA, T. E., W. J. ZIELINSKI, AND R. BARRETT. 1995. The current distribution of American martens (*Martes americana*) in California. *California Fish and Game* 81:96–103.
- MACE, R. U. 1970. Oregon's furbearing animals. Oregon State Game Commission, *Wildlife Bulletin* 6:1–82.
- MARTINSEN, C. F. 1971. History and management of Washington's furbearers. *Washington Wildlife* 23:10–17.
- MASER, C., B. R. MATE, J. F. FRANKLIN, AND C. T. DARNES. 1981. Natural history of Oregon coast mammals. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-133:288–299.
- MAYER, K. E., AND W. F. LAUDENSLAYER. 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection, Sacramento.
- MERRIAM, C. H. 1890. Descriptions of twenty-six new species of North American mammals. *North America Fauna* 4:1–56.
- MILLER, G. S. 1912. List of North American land mammals in the United States National Museum, 1911. *Bulletin of the United States National Museum* 79:1–455.
- OLTERMAN, J. H., AND B. J. VERTS. 1972. Endangered plants and animals of Oregon IV: mammals. Agricultural Experiment Station, Oregon State University, Corvallis, Special Report 364:1–47.
- RAPHAEL, M. G. 1988. Long-term trends in abundance of amphibians, reptiles, and mammals in Douglas-fir forests of northwestern California. Pp. 23–31 in Management of amphibians, reptiles, and small mammals in North America. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-166.
- RAPHAEL, M. G. 1994. Techniques for monitoring populations of fishers and American martens. Pp. 224–240 in Martens, sables, and fishers: biology and conservation (S. W. Buskirk, A. Harestad, M. Raphael, and R. A. Powell, eds.). Comstock Publishing Associates, Cornell University Press, Ithaca, New York.
- RAPHAEL, M. G., AND R. H. BARRETT. 1981. Methodologies for a comprehensive wildlife survey and habitat analysis on old-growth Douglas-fir forests. Pp. 106–121 in Cal-Neva Wildlife Transactions, The Western Section of The Wildlife Society, Sacramento, California.
- RHYMON, L. M. 1969. A critical analysis of wildlife conservation in Oregon. M.S. thesis, Oregon State University, Corvallis.
- RUGGIERO, L. F., W. J. ZIELINSKI, K. B. AUBRY, S. W. BUSKIRK, AND L. J. LYON. 1994. A conservation assessment framework for forest carnivores. Pp. 1–6 in American marten, fisher, lynx, and wolverine in the western United States (L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, eds.). United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-254:1–184.
- SCHMEPF, P. F., AND M. WHITE. 1977. Status of six furbearer populations in the mountains of northern California. United States Department of Agriculture, Forest Service, Pacific Southwest Region, San Francisco, California.
- SHEETS, T. J. 1993. Washington state pine marten distribution. Washington Department of Wildlife, Olympia.
- SHERRELL, P. E. 1970. An annotated checklist of the land mammals of Curry County, Oregon. M.S. thesis, Central Washington State College, Ellensburg.
- SPENCER, W. D. 1981. Pine marten habitat preferences at Sagehen Creek, California. M.S. thesis, University of California, Berkeley.
- THOMPSON, I. D. 1991. Will marten become the spotted owl of the east? *Forestry Chronicle* 67:136–140.
- THOMPSON, I. D., AND A. S. HARESTAD. 1994. Effects of logging on American martens with models for habitat management. Pp. 355–367 in Martens, sables, and fishers: biology and conservation (S. W. Buskirk, A. Harestad, M. Raphael, and R. A. Powell, eds.). Comstock Publishing Associates, Cornell University Press, Ithaca, New York.
- TWINING, H., AND A. HENSLEY. 1947. The status of pine martens in California. *California Fish and Game* 33:133–137.
- UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE. 1992. Final Environmental Impact Statement (FEIS) on management for the northern spotted owl in the national forests. States of Washington, Oregon, and California. Portland, Oregon.
- UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE. 1993. Forest ecosystem management: an ecological, economic and social assessment report of the Forest Ecosystem Management Assessment Team (FEMAT). United States Government Printing Office, 1993-793-071.

- VERTS, B. J., AND L. N. CARRAWAY. 1998. Land mammals of Oregon. University of California Press, Berkeley.
- WENGER, K. F. 1984. Forestry handbook. 2nd ed. John Wiley & Sons, New York.
- WRIGHT, P. L. 1953. Intergradation between *Martes americana* and *Martes caurina* in western Montana. *Journal of Mammalogy* 34:74–86.
- YOCUM, C. F. 1974. Status of marten in northern California, Oregon and Washington. *California Fish and Game* 60:54–57.
- ZIELINSKI, W. J. 1992. A survey protocol to monitor forest carnivores in proposed management activity areas. United States Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, California.
- ZIELINSKI, W. J., AND R. T. GOLIGHTLY. 1996. The status of marten in redwoods: is the Humboldt marten extinct? Pp. 115–119 in *Conference on Coast Redwood Forest Ecology and Management* (J. LeBlanc, ed.). Humboldt State University, Arcata, California.
- ZIELINSKI, W. J., AND T. E. KUCERA. 1995. American marten, fisher, lynx, and wolverine: survey methods for their detection. United States Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-157: 1–163.

Submitted 17 December 1999. Accepted 10 August 2000.

Associate Editor was Ronald E. Barry.