# *Wildlife in Miniature*

## *A Biologist on the Trail of the Yellow-Cheeked Vole*

*This article was prepared by Karin Lehmkuhl, a biologist with the U.S. Fish and Wildlife Service at the Koyukuk/Nowitna National Wildlife Refuge Complex in Alaska.*

Alaska. The name invokes images of snow-capped mountains, massive glaciers, throngs of caribou, grizzly bears, wolves, and moose. But nestled within all of this grandeur lies a secret land of wonder that people seldom notice—and it belongs to Alaska's small mammals. To experience this enchanting place, you must learn to see on a different scale. Blueberry bushes become tall trees, small lakes are immense oceans, and predators are monsters of mythic proportions. Here you will encounter Alaska's mice, voles, lemmings, and shrews. And if you are lucky in your exploring, you will meet one of North America's largest microtine rodents, the yellow-cheeked vole. (Microtine rodents are voles and lemmings, which belong to the subfamily *Microtinae*. This name comes from the Latin *micro* meaning "small" and *otos* meaning "ear.")

Named for its chestnut-gold cheek patches, the yellow-cheeked vole is a social rodent, establishing colonies in moist, grassy areas of the boreal forest region. Enter a yellow-cheeked vole colony and you will discover their well-worn trails, holes, and burrows, perhaps find a stash of horsetails, and hear the voles' high-pitched whistles that alert others in the colony of your presence. Spend long enough in the colony and you may learn the meaning of various vole chirps and whistles or recognize individual voles by their markings and mannerisms.

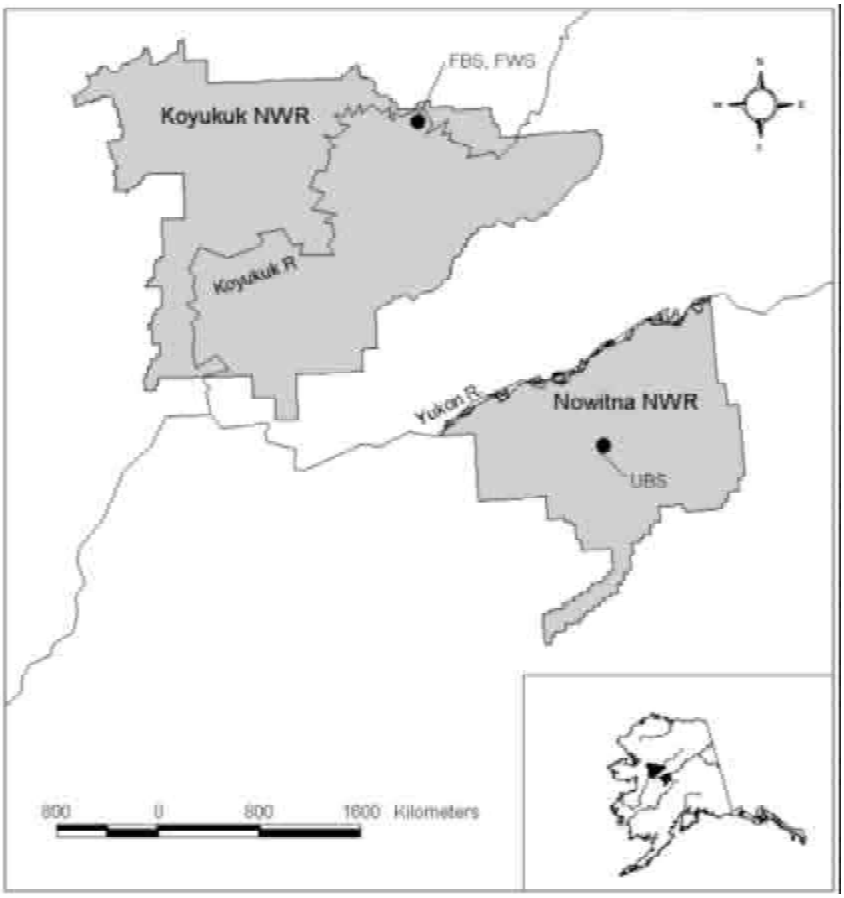
*An adult yellow-cheeked vole, weighing about 140 g. Note the chestnut-colored nose patches and oily flank gland secretion above the back leg.*

These are things I came to know during three summers spent researching yellow-cheeked voles in interior Alaska for the U.S. Fish and Wildlife Service and the University of Alaska Fairbanks. I conducted a mark–recapture study on the Koyukuk and Nowitna National Wildlife Refuges (NWR) to investigate population dynamics and habitat associations of yellow-cheeked voles in regenerating burned areas.

## *The Mystery*

When I began this project, I gathered all the available literature pertaining to yellow-cheeked voles, reaching back to the mid-1800s. Although this boreal forest species ranges from interior Alaska to the shores of Hudson's Bay, the articles pertaining to its life history filled only a single folder. In 1948 one researcher wrote, "what we know of this northern woodland vole can be put in a few words." Only a handful of researchers have studied the species since. How exciting, in this age, to be studying a mammal about which we know so little!

As I read, another mystery emerged. At times, it seems, large colonies of yellow-cheeked voles simply vanish. Where once were hundreds of voles, building trails and churning up soil in their search for roots, there will be none. Where do they go? What do the voles need to survive, and why might they leave? Would my research shed any light on this question? My fascination with yellow-cheeked voles increased as I learned more about the species' life history and social behavior.




*Location of yellow-cheeked vole live-trapping grids on the Koyukuk and Nowitna National Wildlife Refuges, Alaska.*

## *The Voles*

Except for their nose patches, yellow-cheeked voles are gray-brown, with smaller ears and "boxier" heads than their mouse cousins. Their bicolored tails, dark above and light below, are about one-third their body length, not nearly as short as a lemming's. Mature yellow-cheeked voles are hamster size and can weigh 140–170 g (5–6 oz.), with total lengths of 186–226 mm (7–9 in.). Juveniles do not reach sexual maturity until they are nearly a year old, and they remain smaller than adults throughout their first season.

Yellow-cheeked voles begin breeding in early May as the snow melts and herbs and grasses begin to emerge. Females produce one to two litters of 6–13 young (averaging 8–9) between May and July. During this time, males are territorial, aggressively defending their home ranges from other males. Females have overlapping home ranges and primarily defend the areas around their underground nests. Non-reproducing adults and juvenile voles show little aggression toward one another.

In each colony, yellow-cheeked voles build and maintain a network of trails and communicate in part using scent at latrine sites in trail junctions. Oily glands located on the flanks of adult voles secrete a scent that is rubbed onto scent posts or scratched onto the hind foot. Glandular odor may indicate reproductive condition and individual identity, and it may be used in territorial defense.

In mid-August and September, territorial behavior lessens, juveniles begin to mingle and disperse, and food is gathered and stored for the coming winter months. Large underground food caches and middens are excavated. Cache chambers are 20–30 cm high and 0.5 to 1 square meter in size. One cache of horsetail and fireweed rhizomes was found to weigh 3.6 kg (dry weight), about one bushel! These caches supply 90% of the winter food for the voles. Mature yellow-cheeked voles gather winter food with their offspring, but most adults live only until late fall (18 months total). What role adults play in overwinter survival of their offspring is still unclear.

Yellow-cheeked voles spend winters underground in communal nests with five to ten others. This strategy helps them maintain their body temperature during the cold, dark winter months. Interior Alaska winter temperatures average –20°C (–5°F) and can reach –60°C (–76°F). Snow insulates the ground, and surface and soil temperatures are generally higher than the air temperature. The huddling behavior of voles offers even greater warmth. In one study, mean daily air temperatures ranged between –5° and –23°C, while temperatures inside a yellow-cheeked vole midden ranged from +4° to +7°C. Voles left the midden a few at a time to obtain food from the cache, while the others remained in the nest to maintain heat.

Midden groups are apparently made up of individuals from separate families, although female littermates may be found together, and an adult female may visit middens in which her young are staying. The non-relatedness of individuals in middens may prevent interbreeding and reduce the risk of losing a family line to predation. The strategy of communal living and food storage for winter allows yellow-cheeked voles to survive year-round in places that are too harsh for many other small mammals.

Yellow-cheeked voles have been reported from a puzzling variety of habitats within the boreal forest zone. Their range extends from central Alaska to the west coast of Hudson's Bay and from the northern coast of the Yukon and Northwest Territories to central Alberta. The voles seem to prefer moist, early successional stage habitats—areas with good burrowing conditions and lush herbs

and grasses for food. Yet the species has been observed in marshes, sphagnum bogs, banks of streams and rivers, deciduous and mixed woods, lake edges, black spruce forests, burned spruce sites, and grasslands. What do these places have in common? What do yellow-cheeked voles need to survive? What makes *good* yellow-cheeked vole habitat? These are some of the questions that filled my mind as I began my research.

In science there are always more questions than one researcher can try to answer. I knew I could only attempt to understand a small portion of the species' life history, so I chose to study yellow-cheeked voles in forests that were regenerating following wildfire. It had been suggested in the literature that burned areas provide good yellow-cheeked vole habitat, yet no studies had been conducted specifically to investigate vole populations in burned areas and to identify habitat characteristics influencing their numbers. Yellow-cheeked vole populations in relationship to wildfire had become of particular interest in interior Alaska because trappers were concerned about fire effects on pine martens. Martens are primarily associated with mature spruce forest, but on the Nowitna NWR, biologists found them using recently burned areas, where they fed on yellow-cheeked voles. It stands to reason that a better understanding of the prey population would lead to further insight into marten ecology and contribute to our understanding of fire in interior Alaska.

## *Fire and the Boreal Forest*

Wildland fires play an integral role in the boreal forests of interior Alaska. Tens of thousands of acres burn each year, initiating the long process of forest succession. Plants arrive and establish at different times in response to the changes created by fire, resulting in a gradual shift in plant communities over time that ultimately results in mature forest. Spruce forests of interior Alaska are composed of two major community types: black spruce and white spruce. White spruce communities tend to be found in sandy or well-drained soils along riverbanks and on slopes with southern exposure. Boggy areas and slopes with less sun exposure tend to be occupied by black spruce. Fire effects and successional patterns in these two communities are similar but vary in interesting ways. These differences may affect the potential of each habitat type to sustain yellow-cheeked vole populations.

It can take over a hundred years for mature spruce to re-establish in a burned area. Fire in the boreal forest can remove the thick insulating moss layer that has maintained cold soil conditions, creating a bare soil seedbed and blackened surface that heats up in the summer sun. Herbs, mosses, and grasses flourish in these growing conditions. Some plants are adapted to resprout from surviving underground roots and rhizomes, while others arrive as seeds blow in from adjacent areas. This early stage of succession is called the *moss–herb* stage. After about five years deciduous shrubs and saplings have arrived and grow taller than the grasses and herbs, creating the *tall shrub–sapling* stage. In about 30 years the saplings have grown into the *dense tree stage*. Black spruce saplings are usually present now, and by about 60 years after fire a *mixed hardwood–spruce* community has developed. As the hardwoods mature and die out, the *black spruce* community has returned, occupying the site by about 90 years after the burn. White spruce is slower to return to a burned site, and *hardwood* communities dominate for 50–150 years after the fire. Eventually the *white spruce* community is re-established and remains until a disturbance such as fire begins the process again.

| | |
|---|---|
| *Black Spruce Sites* | |
| 0–1 years | newly burned |
| 1–5 years | moss–herb |
| 5–30 years | tall shrub–sapling |
| 30–55 years | dense tree |
| 56–90 years | mixed hardwood–spruce |
| 91–200+ years | spruce |
| *White Spruce Sites* | |
| 0–1 years | newly burned |
| 1–5 years | moss–herb |
| 5–30 years | tall shrub–sapling |
| 26–45 years | dense tree |
| 46–150 years | hardwood |
| 150–300+ years | spruce |

## *The Study Area*

In 1988 a wildfire burned a 16,700-acre (68-square-kilometer) region in the northeast portion of the Koyukuk NWR. Here the topography is relatively flat (the elevation is 5–100 m), with many sloughs and small lakes scattered across the landscape. The fire burned along the west bank of the Koyukuk River, just upstream of the confluence of the Hogatza River. The Koyukuk River provided access to yellow-cheeked vole colonies in both regenerating white spruce and black spruce com-

*Voles were captured in Sherman live-traps.*

munities in the floodplain. I established two sets of paired live-trapping grids in this region: one in the black spruce community and the other in the white spruce.

A third pair of grids was established on the Nowitna NWR near the edge of a 35,000-acre (140-square-kilometer) region that burned in 1985. This gently rolling upland region is primarily vegetated sand dunes, with black spruce communities, lakes, and bogs in the flat valleys between the dunes, and white spruce and deciduous communities on dune ridges. The live-trapping grids were situated in regenerating upland black spruce habitat.

## *Trapping*

Two eager helpers and I established the grids based upon accessibility and evidence of yellow-cheeked vole colonies. The 2,500-square-meter (27,000-square-foot) grids were situated to encompass areas of apparent high vole activity. Each grid contained 100 trap locations spaced at 5-m intervals in a 10 × 10 configuration. The voles were captured in small, folding live-traps that were supplied with bait (sunflower seeds) and cotton bedding material. We trapped at each grid for four days a month during June, July, and August 1997 and 1998 and in June 1999. Rain or shine, a faithful assistant and I ventured out by canoe or on foot to check the traps at 6:00 a.m., 2:00 p.m., and 8:00 p.m. daily. We had to be on time to let the voles out, as they could become too hot, cold, hungry, or dehydrated if left in the traps too long.

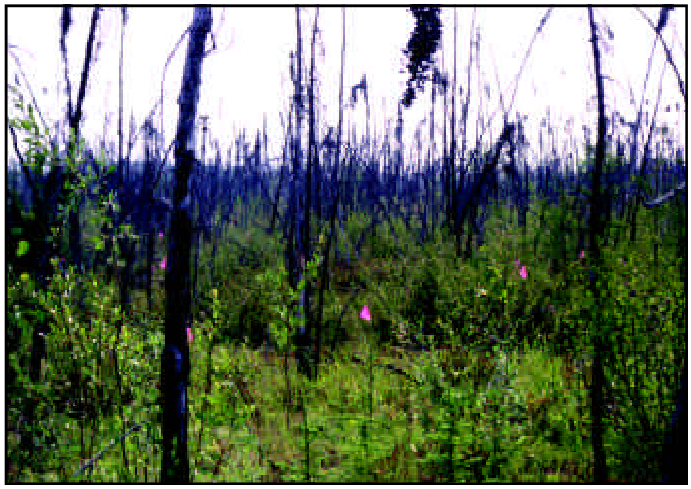
*An electronic scanner reads the unique code from the microchip tag that has been inserted under the vole's skin.*

When a vole was captured, it was marked with a passive integrated transponder tag inserted under the skin. Each tag contains a microchip containing a unique identification code that is transmitted to a handheld electronic reader when scanned, similar to scanning groceries at a supermarket. We kept track of all the new captures and recaptures so that later I could estimate vole abundance and survival and recruitment rates at each site. We also recorded the weight, age class, sex, and reproductive condition of each individual prior to release. We soon learned to distinguish between juvenile (less than 40 g), subadult (young of the year), and adult voles. The few voles that died in the traps were collected for stomach content analysis (in 1997) and museum specimens, and are now archived at the University of Alaska Museum. Occasionally we caught other animals, including red-backed voles, shrews, sparrows, and wood frogs, but these were not tagged.

## *How Many Voles?*

My time spent in the field was rigorous, with many long days, mornings that came far too early, and long hikes and windy canoe trips, but also beautiful evenings, wildflowers, sunny days, and, of course, many voles. All the hard work paid off; in 1997 I captured 482 yellow-cheeked voles 1534 times, and in 1998 I captured 536 voles 2055 times! I kept track of each individual, when and how many times it was captured (called its "capture history"). Some voles were "trap-shy," meaning that after their first capture they avoided the traps. Others were "trap-happy," and we caught them frequently, sometimes twice during the same trap check! We learned to recognize many voles by their appearance and behavior.

We were able to watch juveniles mature into subadults during their first summer, and we saw them again as adults the following year. I tagged one female as a juvenile in 1997 and caught her as an adult in 1998 and again as a "grandmother" in 1999, which means she lived at least six months longer than most yellow-cheeks.



*A regenerating black spruce site, showing the small snags and the dwarf birch and young black spruce in the understory.*

*A regenerating white spruce site, lush with grasses and herbs such as fireweed. The snags are larger and less dense than in black spruce sites, and there are fewer shrubs.*

Now that I had collected all these data, I needed to estimate population characteristics (such as abundance and survival) at each trap site so that I could determine the relative quality of each habitat. Alaska winters are long but not long enough for one biologist to sort through all of these data by hand! Luckily I was able to use several cutting-edge computer modeling programs that use the capture histories of each vole and generate population parameter estimates. I specifically looked at vole abundance and density at each site in each month of trapping, as well as survival, reproduction, and immigration rates between months.

At nearly every site, vole captures and abundance estimates increased over the summer. Most new voles entered the populations through reproduction between June and July and through immigration through July and August. The immigrants were mostly subadults from adjacent areas that were beginning to move away from their birth sites.

Yellow-cheeked vole abundance was generally higher in the floodplain white spruce grids than in the black spruce sites. The estimated density peaked in August 1998 at 163 voles per hectare on one of the floodplain black spruce sites. Compare this to a low of 13 voles per hectare observed at one of the upland black spruce sites in June 1998!

The vole populations in the white spruce had higher rates of reproduction, immigration, survival, and site fidelity than those in the black spruce sites. In fact, of the 40 voles that were tagged in 1997 and recaptured the following summer, 30 were residents of white spruce grids, indicating that overwinter survival was high. On the other extreme, I encountered a case of "disappearing voles" in the upland black spruce. I captured 34 voles at one upland site in June 1997 and never saw any of them again! Other voles moved into the area, so the colony remained populated, but what happened to the voles that vanished? I even set out live traps in adjacent areas to see if some had wandered away, but I never found any of the missing voles.

## *What Makes "Good" Vole Habitat?*

The evidence we saw while trapping, and the population characteristics I estimated, indicated that yellow-cheeked voles were utilizing all of the study areas and were particularly flourishing in the burned white spruce habitat. I investigated some of the unburned areas near the trapping grids but rarely saw signs of yellow-cheeked vole activities there. Why did the voles prefer the burn? What made the regenerating white spruce communities such a good place to live?

For a given habitat to sustain viable populations of a species, it must supply sufficient food, water, predator escape cover, and shelter. Yellow-cheeked voles need vegetation for food, cover, and shelter, and they rely on proper soil conditions for burrow construction. To get a vole's eye view of each grid, I measured characteristics of the vegetation and soil and compared conditions between burned and unburned areas.

### *Soil Conditions*

Soils in the burned areas were warmer than in adjacent unburned areas, and the seasonally

thawed layer (the active layer) above the permafrost was thicker. Such temperature differences are important to an animal living underground during the harsh northern winter. A deep active layer allows the voles to excavate large middens and food caches. Soil warming is a typical result of fire in the boreal forest, because the fire removes the insulating layer of moss and creates a blackened surface that absorbs the sun's rays.

The soils at the floodplain sites tended to be warmer and drier than in the upland sites. Remember the voles that vanished from the upland black spruce site? That area had particularly wet soil, and the water table rose during the month that the voles left, flooding some of the burrows. Perhaps the increased moisture, which was accompanied by low soil temperatures, contributed to the voles' disappearance.

*Snags and Logs*

Logs provide important cover for yellow-cheeked voles, and runways were often constructed underneath them. Burrows, especially those in which young were born, were frequently located in the root wads at the base of snags and logs. Since white spruce tends to be much larger than black spruce, the cover provided by the snags and logs at these sites was significant. The taller, larger white spruce trees were probably more susceptible to windfall, so there tended to be more logs in the white spruce sites and more standing snags in the black spruce habitats.

*Vegetation*

Plants may be the most important factor influencing the distribution and population dynamics of microtine rodents. Vegetative cover affects the microclimate at the soil surface, combines with loose snow cover to enhance winter insulation, and provides escape cover from predators. Vegetative cover in the black spruce grids was patchy, with dense shrubby areas interspersed with open areas of little vertical cover. The white spruce sites were more uniformly covered with a dense growth of grasses and herbs.

*A juvenile yellow-cheeked vole, weighing under 40 g.*

Of course, plants also provide food for yellow-cheeked voles. Both the literature and the results of our stomach content analysis indicated that yellow-cheeked voles have a preference for horsetails, grasses, fireweed, and blueberries. These species can be common in early post-fire successional communities and tend to be less common in mature spruce forests. The plants were present to some extent at all of the trapping grids, but horsetails, grasses, and fireweed were particularly abundant on the white spruce grids. Bluejoint reedgrass is a particularly aggressive invader of burned white spruce stands and has been reported to persist in association with fireweed for 100 years or more! Both plants can sprout from rhizome sections, and their growth may be fostered by the digging, collecting, and caching behavior of yellow-cheeked voles. While trapping we saw areas of vole-churned soil in which grasses were sprouting, as though a garden had been tilled and planted!

## *What's on the Menu for a Yellow-Cheeked Vole?*

In 1997 the stomach contents of 29 yellow-cheeked voles that had died in traps were analyzed to determine what the voles had been eating. The voles were collected in all study sites, and the diets were similar despite differences in the vegetative communities. Species of horsetail contributed approximately 50% to the vole diet, and berries (mostly blueberries) made up another 15–30%. A fair amount of fungal spores were present in the diet, especially at the floodplain black spruce sites. Other berries, forbs, grasses, and lichens contributed to their diet in small amounts, while shrubs and mosses occurred only rarely.

It is interesting that yellow-cheeked voles are so fond of horsetails. The plant has been nicknamed "scouring rush" because of its rough texture. Horsetails contain silica and can be used by campers to scrub pots. The stem of the plant is segmented and can be easily "popped apart." Several times I watched yellow-cheeks pluck up a horsetail and pull apart each section to eat. Often I would find piles of horsetails at burrow entrances where the voles would sit and eat. The voles were clearly fond of berries as well and would reach up

*Whenever you see grasses, horsetails, and fireweed—three of the yellow-cheeked voles' favorite foods—keep an eye out for yellow-cheeked voles.*

to pluck blueberries off the bushes as you might pick an apple.

Other researchers have also documented the species' affinity for horsetails and berries. In addition, grasses and fireweed have been observed to be important food items for yellow-cheeked voles. These plants may be of greater use during seasons not represented in my sample (June–August). Fireweed possesses thick starchy rhizomes that are stored for winter consumption. I recently encountered an autumn food cache that was composed almost entirely of grasses and sedges.

My experience in interior Alaska has been this: wherever there are grasses, fireweed, and horsetail growing abundantly, there are likely to be yellow-cheeked voles!

## *Why Live in a Burn?*

All of the yellow-cheeked vole colonies we studied were located in sites where the fire had caused soil warming, created snags and logs for cover and burrows, and provided favorable conditions for preferred forage species. The white spruce sites were particularly suitable for colonization because of the warmer, well-drained soils, large logs and root wads, and abundance of grasses and forbs. Differences in successional patterns in black and white spruce communities may allow yellow-cheeked vole populations to persist at higher densities and for longer periods in regenerating white spruce sites than in black spruce habitats. Only time will tell how long the voles remain and prosper at my study sites. And further study will reveal whether the patterns I observe hold true in other areas.

## *Still Learning*

As I finish writing this article, I am sitting in a tent in the middle of a colony of yellow-cheeked voles. Outside I can hear them whistling to each other, speaking a language I have yet to master. My time spent trapping voles was enlightening and fulfilling, but I know I learned only one small piece of the puzzle. The wonderful small world of yellow-cheeked voles will always fascinate me. On your next walk outdoors, look down, pay attention to little things, and perhaps you will find yourself lost in the land of small mammals too!

## *Suggestions for Further Reading*


Conroy, C. J., and J. A. Cook (1999) *Microtus xanthognathus*. Mammalian Species, vol. 627, p. 1–5.

Lehmkuhl, K.L. (2000) Population dynamics and ecology of yellow-cheeked voles (*Microtus xanthognathus*) in early post-fire seres of interior Alaska. Master's Thesis, University of Alaska Fairbanks.

Wolff, J.O., and W.Z. Lidicker, Jr. (1980) Population ecology of the taiga vole, *Microtus xanthognathus,* in interior Alaska. *Canadian Journal of Zoology,* vol. 58, p. 1800–1812.

Wolff, J.O., and W.Z. Lidicker, Jr. (1981) Communal winter nesting and food sharing in taiga voles. *Behavioral Ecology and Sociobiology,* vol. 9, p. 237–240.