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Habitat Associations and Movement Patterns of Reproductive Female Wolverines (*Gulo gulo luscus*) on the Southeast Alaska Mainland: A Pilot Project

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Cover photo: A wolverine near a live trap taken with a Stealthcam® infra-red camera

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INTRODUCTION

Despite significant gains in our understanding of wolverine ecology and habitat associations in North America over the last 2 decades (Hornocker 1981, Magoun 1985, Gardner 1985, Banci 1987, Copeland 1996, Persson 2003, and others), a major gap exists in our knowledge of wolverines inhabiting coastal ecological zones. For example, in Southeast Alaska (SE AK) the only information available on wolverines are sealing records of animals taken during the hunting and trapping season. These records only contain information on hunter or trapper identification, date of harvest, location and method of harvest, and sex of the animal. During the 10-year period 1994-2003, trappers and hunters harvested an average of 24 wolverine annually in SE AK, with Game Management Unit (GMU) 1B producing an average of 7 (range 1-18) wolverines. Sealing records indicate that GMU 1B typically produces the highest wolverine harvest in SE AK.

The large expanse of remote, mountainous habitat in SE AK has provided wolverines with expansive refugia from trapping, which has probably helped sustain viable populations in the region along with immigration from Canada by way of major river systems. However, recent genetic studies indicate that there may be less interchange between SE AK wolverine populations and those in adjacent Canadian provinces and further genetic studies are needed to determine the extent of dispersal between populations (Tomasik and Cook 2005). Krebs et al. (2004) and Magoun and Copeland (1998) emphasized the importance of functional refugia in maintaining source populations to repopulate areas where trapping occurs. Refugia must be large enough and contain enough suitable habitat for reproductive females to successfully den and rear kits without having to make excursions into trapped areas. There is, however, no information currently available on denning habitat, home range size, or the extent or frequency of extra-territorial movements for reproductive female wolverines in SE AK.

A key component of viable wolverine populations is the survival of reproductive females (Persson 2004). Although mature female wolverines have the capacity to produce 2-3 young per year, studies have shown that the actual reproductive rate for wolverines is much lower than expected, primarily due to delayed maturity and frequent failure to recruit young in years following successful reproduction (Persson 2004). Research conducted in other study areas indicates that survival rates for wolverines are substantially higher in untrapped populations than in trapped populations, and estimates of logistic growth rate for trapped populations indicate that wolverine populations would decline in the absence of immigration from untrapped populations (Krebs et al. 2004). Population viability analyses of wolverines in Sweden indicate that, for populations to remain viable according to IUCN classification criteria (IUCN 2000), the number of sexually mature females (≥3 years old) should exceed 46 individuals (Persson 2003). Sealing records for SE AK (including GMUs 1-5) indicate an average annual harvest of 24 wolverines, with approximately 40% females. There is no information on the age or reproductive status of harvested animals and no estimates of population size for SE AK.

Resource development, human settlements, and increased human access in wolverine habitat can have negative impacts on wolverine populations, especially where dispersal potential for wolverines is compromised by disjunct habitats or lack of refugia (Weaver et al. 1996). Landscape-scale development activities in wolverine habitat such as those resulting from forest management activities not only modify habitat characteristics but affect wolverine movements (unpublished data from studies in British Columbia and Ontario). Road construction associated with forest management activities can greatly improve trapper access to previously untrapped areas that functioned as refugia for reproductive segments of a wolverine population (unpublished data from studies in British Columbia and Ontario). Mortality rates for wolverines in trapped populations has been reported to be as high as 55% depending on the sex and age class of the individuals trapped, therefore, we know that trapping can have a significant effect on wolverine population demography (Krebs et al. 2004). Roads also provide travel corridors for wolves, further increasing the potential for mortality of denning females and their kits (Magoun and Copeland 1998; unpublished data). Significant portions of the GMU 1B Mainland are likely to be impacted by forest management in the foreseeable future. The U.S. Forest Service and the State of Alaska Department of Natural Resources each have plans to log portions of the GMU 1B Mainland and much of this timber harvest activity is scheduled to occur in currently undeveloped areas known to support wolverines.

There have been no studies of wolverines in SE AK or any other coastal ecosystems, largely due to the expense and inherent difficulties associated with studying the species in these ecosystems. Wolverine populations are notoriously difficult to study because of the remoteness of their habitats, the size of their home ranges, and their low density compared to other mid-size carnivores. Acquiring information on reproductive females is particularly difficult because their home ranges are distributed in the most remote areas of occupied wolverine habitat. Past experiences of wolverine researchers suggest that a pilot study should be undertaken to determine the most feasible and cost-effective way to carry out wolverine research in ecosystems that have not yet been studied. For this reason, we propose to conduct a pilot study to determine which portions of the GMU 1B Mainland are most likely to support reproductive female wolverines and what methods are suitable for documenting their movements and habitat associations. The information from this pilot study will not only help in developing a more comprehensive study of the habitat requirements and movements of reproductive females, but also provide information on the distribution of potential source habitats for wolverines in the region.

STUDY AREA

The study area comprises the mainland of SE AK from Port Houghton southward to the Stikine River drainage. This area includes portions of GMU 1B and 1C as well as portions of the Juneau, Petersburg, and Wrangell Ranger Districts (U.S. Forest Service).

GOALS AND OBJECTIVES

We proposed a pilot project to determine the feasibility of establishing movements and habitat associations of wolverines, particularly reproductive females, in GMU 1B in relation to potential timber harvest activities in the region. The ultimate goal of this research is to provide wildlife managers with the information necessary to ensure that functional reproductive habitat is maintained in the face of increasing human development and access to remote areas in the region.

The specific objectives for the first year of the project:

1) investigate methods that can be used to gather information on wolverine movements, home range, and denning habitat in GMU 1B
   a. Live-trapping
   b. ARGOS and VHF collars
   c. Hair-snagging
   d. Infra-red cameras
   e. Snow track surveys from aircraft
   f. Carcass collection
2) develop an expanded study plan for determining habitat associations and movements of wolverines, particularly reproductive females.

METHODS

Live-trapping

We live-trapped wolverines using box traps built with 4-in x 5-in rough hewn timbers that were roughly 60-in-long, 30-in-wide, and 20-in-deep (Figure 1). The heavy timber lid is triggered by the wolverine when it pulls at a piece of bait secured inside the trap at the back near the floor and connected by a cable to a panic snap on the outside of the trap. A cable, which runs from the front of the trap lid, over a cross member above the trap, to the back of the trap where it is attached to the panic snap, holds the lid up until the wolverine tugs on the bait and releases the panic snap. We lubricated the trigger mechanism with petroleum jelly and covered the trigger with a plastic bag to prevent ice build-up. We removed loose hide from deer and moose carcass parts used as bait to prevent a wolverine from stripping lengths of hide from the bait, which might lengthen the distance between the bait and the back of the trap. This prevented the possibility of a wolverine triggering the trap while its head is up or its body is in the trap opening.

With the amount of snow and rain in the study area in 2006, trap lids were heavy enough (>45 kg) that the wolverines could not lift the lids and escape; however, this weight was the minimum necessary to keep the wolverines from lifting the trap lid. A lid-locking mechanism was attached to one trap to prevent the lid from being lifted by a wolverine inside the trap. To prevent escapes or possible injury to animals, we will attach these mechanisms to all traps lids in the second year of the study because lids may dry out and become lighter.

We attached “chew” logs to the front side of the traps where wolverines most often try to chew out of the trap. This log is easily replaced when it becomes worn. However, due to the softness of the spruce timbers used for the traps, on 2 occasions wolverines chewed out of the traps in <8 hours and escaped, once at the front corner of the trap and once through the floor of the trap (Figure 2). After the escapes, all traps were reinforced with hemlock lumber inside the traps and, in some cases, plywood on the outside of the traps. This prevented further escapes. We deployed one culvert-style live trap (Figure 3), which has been used successfully to live-trap wolverines in British Columbia, Canada (L. Goodwin, personal communication).

We checked traps daily, either physically or by listening for signals from trap-monitoring transmitters (Telonics, Inc.) attached to the traps. One trap could not be monitored with a trap transmitter and had to be visited daily; there were 2 instances when inclement weather and ice prevented us from reaching this trap within a 24-hour period but we visited the trap within 48 hours and no wolverines were captured during those periods. Most traps with trap monitors were physically checked every other day but in one case up to 4 days passed before we checked the trap. During periods of cold weather and heavy snow followed by warm weather and rapid thawing, traps must be checked every day because water can build up inside the trap. No wolverine was left in a trap for >24 hours and in most instances <12 hours. No wolverines were injured or killed during the capture process.

We anesthetized captured wolverines with tiletamine HCl and zolazepam HCl (Telazol®) at a dosage of about 10 mg/kg administered with a jabstick and a modified 4 cc Cap-Chur® dart. However, after the first two wolverines were handled, we replaced the capture dart with a 6 cc syringe and 18-guage needle attached to the jabstick. Drug delivery was more efficient and successful with the syringe. We used a long stick to distract the wolverine while we slowly moved the jabstick and syringe close to the injection site (shoulder or rump) and then quickly jabbed the animal with the syringe. We used a light dose of ketamine to immobilize a male wolverine that was recaptured a week after its initial capture; the animal was immobilized to remove porcupine quills.

After the wolverines were immobilized, we weighed the animals, measured the head and neck circumferences, took blood samples, and pulled hair for DNA and stable isotope analysis. We also photographed the ventral side of the animals because wolverines can be identified by the light-colored markings on the chest, throat, and chin area. We photographed this pattern while the animal was lying on its back, before and after collaring the animal, and again as the animal was coming out of the anesthesia to record differences in the pattern when the animal is in an upright position, as seen from the front and from the left and right sides. The photographs could then be compared with photographs taken of wolverines by infra-red cameras at other sites.

ARGOS/VHF collars

We used three ARGOS/VHF satellite collars manufactured by Sirtrack and custom-made for the project (Figure 4). The collars were constructed of rolled leather, rather than the usual machine belting material, to reduce weight and bulk and eliminate wear on the neck of the animals. Because the collars were large enough to fit adult male wolverines, we lined the inside of the collars with flexible silicone rubber to fit younger animals after the first deployed collar was shed by a subadult female. We had VHF-only collars available in case we captured more than 3 individuals. If we did not deploy a transmitter on a captured animal, we visually marked the animal by placing a nylon cord loosely around the neck of the animal with an attached vinyl pendant of a unique color and shape (Figure 5).

The ARGOS PTTs emitted signals around the clock (i.e., we did not program a duty cycle to extend the life of the collars). We downloaded locations daily using the ARGOS internet and email services and entered the locations in a GIS database. We also collected VHF locations in April using a PA-18 Supercub and added those to the GIS database to compare to the ARGOS locations. We collected information on the habitat where the animals were located during the VHF tracking flights.

Hair-snagging

We tested barbed-wire hair snags on captive wolverines to determine if wolverines would approach the snagging device and leave hairs in the barbs. After testing, we set up hair-snagging devices in March and April in the study area. We used double-stranded wire with 4-point barbs. At each site, we used 4 pieces of wire each about 1 meter in length. We mounted the pieces horizontally on 6 upright supports that had been attached along the length of a log, 3 to a side. There were two lengths of barbed wire on each side of the log with the lower piece positioned about 15 cm above the log and the upper piece about 30 cm above the log (Figure 6). We wired a piece of deer meat (with the hide removed) to the log in the center of the snagging structure. We covered the bait with either moss or a piece of cotton to discourage visitation by birds. We checked the devices for hairs each time we visited the live-trap sites.

Infra-red cameras

We set up digital infra-red cameras, which were triggered by a combination of heat and motion, both at live-trap sites to monitor activity at the traps and at additional baited sites to photograph chest patterns. To photograph chest patterns, we attached a camera to a tree so that it faced the upper end of a run pole (Figure 7). We positioned bait approximately 40 cm above the run pole and 30 cm in front of the run pole so that a wolverine would look up at the bait as it approached the end of the run pole. We used deer meat, beaver castor, and bacon, either separately or in combination, and placed most of the bait inside a cloth bag to prevent other species from removing all of the bait from the site.

Track surveys

We used a PA-18 Supercub to find wolverine tracks in alpine and forested portions of the study area to determine if it would be possible to conduct aerial track surveys of wolverines in SE AK similar to those conducted in forested areas of Ontario (Magoun et al. 2007).

DNA analysis

We cooperated with Dr. Joe Cook of the University of New Mexico in a comparative study of wolverine genetics in SE AK and adjacent provinces of Yukon and British Columbia to determine the level of interchange between populations in SE AK and Canada. We contacted trappers in SE AK by mail and notified them of our research project on wolverines and informed them that we would purchase skinned wolverine carcasses for $25. Dr. Cook and his graduate students contacted biologists and trappers in Canada. Carcasses collected from Alaskan trappers were sent to the University of New Mexico for DNA analysis.

RESULTS

Live-trapping

We deployed live traps at 8 sites and operated them for a total of 246 trap nights from December 30, 2006 – April 2, 2007. Wolverines triggered the traps 7 times. We captured 4 wolverines (3 males and 1 female) and recaptured one of the males a week after its initial capture. Wolverines escaped twice from traps by chewing out (Figure 2). Photographs from cameras set at trap sites indicated that at least 2 wolverines visited the trap sites but were never captured, either because the traps were not set at the time of the visit or the animal failed to trigger the trap. One of these animals was captured on video tape entering and leaving the trap without triggering the trap.

We anesthetized the 4 wolverines that were held in the traps and put collars on 3 of these. We could not collar the fourth animal, a subadult male, because of an old injury on its neck that would have led to chafing by the collar. Instead, we placed a colored vinyl pendant loosely around the neck of the animal at the initial capture, which was still attached when we recaptured the animal a week later (Figure 5). This animal had recent wounds on its face that were beginning to heal, had porcupine quills in its face, and was blind in one eye. Nevertheless, it appeared in good condition and weighed nearly as much as an adult male. Males weighed 12-13 kg and the female weighed 9 kg.

The only other species caught in the live traps were marten. One mink was killed when the trap lid fell on it as it entered from the side of the trap.

ARGOS/VHF collars

Two subadult wolverines (a male and a female) removed their collars within days of their captures so we obtained very few locations for these animals. We placed the third collar on an adult male and that unit has remained on the animal and functional for over a month. From April 3 – April 30, we received 83 locations from the ARGOS PTT, with an average of 3 locations per day. There were no locations on 3 days during that period. The highest number of locations for any single day was 10. Most of the ARGOS locations (82%) were in the A or B location class (i.e., accuracy unknown). To obtain a sample of accurate locations, we radio-tracked the wolverine from the air 15 times during this period using the VHF signal. Locations acquired with the VHF signal were generally distributed in the same areas where ARGOS locations were distributed and concentrated in the same areas as the ARGOS locations (Figure 8). The minimum convex polygon calculated from the ARGOS locations (1432 km^2) was larger than that calculated using the VHF locations (427 km^2).

Hair-snagging

We deployed hair-snagging devices at 5 sites, all at locations where we knew wolverines were active. We snagged wolverine hair on only one barb at only one site. The only other evidence of visitation at the hair-snag stations was down feathers, which were left by birds on many barbs at most sites.

Infra-red cameras

We deployed 14 infra-red digital cameras from 3 different manufacturers (Trailwatcher, Stealthcam, and Cuddeback) at 11 sites near sea level within the study area. We photographed wolverines at all but 2 of these sites, one of which was <800 m from another camera site where a wolverine was photographed. Using a combination of cameras and live traps we documented at least 7 different wolverines at the baited sites (Figure 8). Two wolverines captured in live traps did not leave recognizable chest patterns on cameras even though both were suspected of being photographed at the trap sites. One wolverine captured in a live trap was photographed with a recognizable chest pattern both at the trap site and at a separate camera site. A third wolverine was photographed at 2 different trap sites and a separate camera site with good chest pattern photos at all 3 sites. Three wolverines identified by photographs at trap sites were not live-trapped or were captured but escaped before we returned to the traps. Other species photographed at the trap sites included weasel, marten, flying squirrel, porcupine, deer, moose, Steller’s jay, and bald eagle.

Track surveys

Due to a winter with frequent and heavy snowfalls and rainstorms, we were only able to search for wolverine tracks from aircraft on 4 days in the February – March period. On those days with good tracking conditions and favorable winds, we were able to find wolverine tracks both in alpine areas and in forested areas in openings such as rivers, creeks, ponds, lakes, forestry roads, and muskeg. Although weather improved in April, tracking conditions deteriorated because of rapid freeze/thaw cycles.

DNA analysis

We sent 13 wolverine carcasses, 1 tissue sample from an additional wolverine, and hair from the 4 captured wolverines to the University of New Mexico for DNA analysis. Analysis is currently underway.

DISCUSSION

Live-trapping

Although we reinforced the wooden live traps, we still had to monitor the traps frequently to minimize the period between when a wolverine was captured and when we arrived at the trap to prevent escapes. The trap monitoring devices were invaluable in helping to shorten the period when the wolverines were in the traps. For example, a wolverine caught in a trap that had been reinforced with hemlock chewed on several areas of the trap, apparently testing for weaknesses, and finally began to chew on the inside of the trap lid, the only area that we had not reinforced. He had nearly chewed out of the trap through 4-in x 5-in spruce timbers by the time we arrived at the trap, which was <8 hours after we had set the trap. We recommend that all wooden live traps be constructed of at least 4x4 hemlock timbers, or other hard, dense wood, and that all possible weak areas be reinforced with additional wood. The chew log should be made of the lightest, least dense wood in the trap to encourage the animal to chew there rather than more critical areas of the trap. A chew log in each corner and across the top and bottom at both the front and back of the trap should give the animal plenty of material to chew on before reaching the harder wood.

We also recommend that a trap-locking mechanism be constructed to prevent the lid from being pushed up by the trapped wolverine. Photo evidence at one of our trap sites indicated that a wolverine, an adult male, was able to lift the lid a few centimeters from inside the trap. He might have been able to lift the lid far enough to escape had the lid been lighter, as has happened in other wolverine studies; this could lead to the death of the animal if it is caught between the lid and the trap while trying to escape. In addition, when setting the traps, the lid should be given several hard side-to-side shakes to be sure that the trigger mechanism is set firmly and will not prematurely release the lid while an animal is between the lid and the side of the trap. A lightly-set trigger was responsible for the death of a mink.

The culvert-style live trap was not deployed long enough to test the efficacy of the trap in capturing wolverines. We documented no visits by wolverines where this trap was set. We caught only one marten in this trap. The only other mammal species we documented entering any of the traps were mink and weasel, neither of which triggered any of the traps. Steller's jays also entered both types of traps and removed bait but did not trigger the traps.

ARGOS/VHF collars

We took a conservative approach to collaring wolverines in this study to avoid any potential for neck injury due to collar abrasion. Neck circumference was only 27 cm for the female wolverine we captured, which was relatively small compared to wolverines in other parts of Alaska (Magoun 1985). Because we suspected that this animal might have been a subadult, we adjusted the collar circumference to 30.5 cm to allow for further growth; young wolverines can have as much as a 3-cm increase in neck circumference between November and April (Magoun, personal observation). Unfortunately, the animal was able to slip the collar off shortly after it was captured. For a subadult male that was also able to slip its collar shortly after capture, we had also allowed for 3 cm of growth because testes size for this animal indicated it was not mature and the difference between the neck and head circumference was more than 3 cm, indicating a young animal. On the adult male that we collared, we only allowed for 1.5 cm of increase in neck circumference, because there was little chance that neck circumference would change appreciably (difference between neck and head circumference was only 2 cm). This adult male has retained the collar for over a month and is still providing locations. Based on measurements from these 3 animals, wolverine collars for SE AK should be adjustable between 29 and 35 cm.

Satellite reception of signals from the ARGOS PTTs was better than expected given the rugged topography, amount of forested habitat in the study area, and the preponderance of ARGOS and VHF locations that fell within forested habitat. Signal strength of the

VHF units was generally good; we failed to locate the animal on only 2 of 17 flights, mainly because of a low ceiling at the time of the flight.

The 83 ARGOS locations were clustered in 4 general areas of the wolverine's home range and 1-5 of the VHF locations fell within each of the ARGOS clusters indicating that ARGOS locations were representative of the areas used by the wolverine. Two ARGOS locations were obviously large errors, being far from the rest of the locations and across Frederick Sound, so they were eliminated from the dataset. Five other locations were plotted over salt water but were close enough to shore and other ARGOS locations that the general location of the animal was probably within the error range of most other ARGOS locations. The relatively small size of the minimum convex polygon of VHF locations compared to that of the ARGOS locations (Figure 7) was probably due to inherent error in ARGOS locations and the small number of VHF locations compared to ARGOS locations. Most of the ARGOS locations that fell outside the VHF polygon were east of the VHF polygon in an area we suspect that the wolverine visited but spent little time in due to the large amount of glacier habitat in the area. We will use additional ARGOS locations gathered over the next 3 months and VHF locations next winter to more accurately define the home range for this animal.

Using the VHF signal, we were able to locate and see the adult male wolverine bedded down near a fallen tree in an area with many old and new wolverine tracks. Because the circumstances suggested that the site might be that of a denning female, we flew into the area with a helicopter and placed 3 infra-red cameras around the site to try to document wolverine kits. We will retrieve these cameras in late June. This possible den location was in the middle of a cluster of ARGOS locations and was an area where we had located the male wolverine 4 times with the VHF signal. Two other clusters of ARGOS locations for this male may indicate where resident female wolverines reside, although we cannot rule out the possibility that the clusters are focused on food caches.

Additional ARGOS locations are being downloaded daily and we expect the PTT to continue to send signals through July if the antenna on the collar is not damaged. Analysis of the ARGOS data is ongoing. No additional VHF locations will be collected until January 2007 because the tracking aircraft will not be available until then. The VHF battery life is expected to last until March 2007.

Development of GPS collars for wolverines has not progressed to the point that we would recommend use of GPS collars at this time. Technical problems with some models and the weight and bulk of other models are still an issue with this technology for wolverine studies. GPS units used in Montana on wolverines were drop-off collars that were programmed to fall off after 3 months because of the size of the units (R. Inman, personal communication). In our study area, retrieval of these collars would be expensive with no guarantee that the collars could be retrieved, and the accuracy of locations does not offset the short duration of these collars compared to ARGOS/VHF collars. Unless very accurate locations are required for detailed movement and habitat analyses, we suggest that the lightweight Sirtrack ARGOS/VHF collars are a better choice for obtaining information on wolverine home range location and general movement patterns.

Hair-snagging

Although we tested the hair snagging technique in the field at only 5 sites, preliminary results and our work with captive animals suggest that wolverine hair will not snag easily on barbed wire until at least late winter. We were only able to easily remove hairs from captive animals and from animals that we caught in the live traps after February; until then, hairs were difficult to remove or broke off without including the follicles. For this reason, we would not recommend trying to snag hair until March. We recommend that hair-snag stations be constructed earlier in the winter, pre-baited, and then run for a 1-month period in March before black bears emerge from hibernation. Because of frequent rain and above freezing temperatures, the stations would need to be visited frequently and the hair collected to prevent deterioration of DNA. We also recommend that baits be tightly enclosed in cloth bags so that birds cannot remove the bait and are discouraged from visiting the stations and leaving feathers on the barbed wire. If the stations are pre-baited before March, the bait should be placed at a distance from the barbed wire to prevent contamination before the sampling period begins.

We do not recommend hair-snagging as a method for estimating population size based on mark-recapture methods or establishing distribution patterns of wolverines for a number of reasons besides the short sampling period. Much of the study area would need to be accessed by expensive helicopter flights, pre-baiting of sites would be advisable, and the snagging devices would have to be checked frequently once they were operational. There can be problems with too few hairs collected at a site for DNA analyses, deterioration of DNA, contamination by other species or more than one wolverine at the same site, or multiple samples of the same individual requiring additional costs for analysis for this single individual. Moreover, hair snagging for estimating population size or distribution would require handling large amounts of barbed wire, baits, and other materials for building the snagging devices. Finally, there is often a long delay between collecting the hairs and receiving the analysis of individual identities of wolverines from the DNA laboratory. Because cameras can be deployed for the entire winter period, require little material for set-up, last 3 weeks or longer before new batteries are needed, and can be used to identify all individual wolverines and other species that visit the sites as soon as photos are downloaded, we consider cameras a better choice for documenting wolverine occurrence. Nevertheless, hair snagging would be useful for verifying the sex of animals visiting camera sites. Identification of sex from hairs is less expensive, more easily obtained, and has less error than determining individual identity, and hair-snagging devices would only have to be deployed at camera sites that were being visited by wolverines.

Infra-red cameras

Infra-red cameras made it possible to identify 3 additional wolverines that we were not able to capture during the study. It is likely that all 7 wolverines identified in the study area, either by live trapping or camera trapping (or both), would have been identified by camera trapping if we had concentrated our efforts on camera trapping rather than live trapping. In addition, from the camera photos we suspect that there may have been 1 and possibly as many as 3 other wolverines that visited our baited sites but were not documented well enough for us to identify them as different wolverines. With further refinement of the camera trapping technique and an increase in sampling effort, cameras have the potential for documenting minimum population size and for a mark-recapture effort to estimate population size. They can also provide information on distribution and turnover rate in the population.

The cameras were also very useful in monitoring the live traps. Because snow was not always present at a trap site or wolverine tracks in snow were obliterated before we checked our traps, the cameras documented wolverines at some traps that we would otherwise have been unaware of, including one wolverine that was going in and out of a trap without being caught.

Track surveys

Although we did not have enough suitable weather for conducting an aerial survey of wolverine tracks throughout our study area, we anticipate that a survey that requires repeated sampling of survey units (Magoun et al. 2007) would be difficult to carry out under normal winter conditions in SE AK. In a study in Ontario, 26 days of suitable survey weather were required to complete a survey in 60,000 km^2 of low elevation, relatively open forested habitat. In SE AK, rainy or overcast weather and low clouds are the rule rather than the exception in winter, and windy conditions in mountainous habitat would further compromise a survey team's ability to find and examine potential wolverine tracks from the air. In addition, wolverine tracks would not be detectable in much of the closed forest stands at lower elevations. Our preliminary telemetry data indicate that wolverines may spend considerable time in forested areas and therefore a large percentage of tracks that are present might go undetected in aerial surveys as described by Magoun et al. (2007). We recommend that if a similar aerial survey is designed for SE AK, sampling units should be large (e.g., 1000 km^2) and rather than use a transect through the unit as in Magoun et al. (2007), the survey team should thoroughly search the unit for tracks and estimate the percentage of the unit that is forested. The units should be ranked based on tracking conditions during the flight, including snow conditions, wind conditions, and ruggedness. The distribution of repeated sampling in a proportion of the survey units, to account for detectability (MacKenzie 2006), should be based on forest cover as well as tracking conditions and survey effort during the previous survey of the units.

DNA analysis

Additional carcasses are needed for DNA analysis. Because trappers opted to keep the skulls from the wolverine carcasses, skeletons of specimens collected in 2006-2007 are incomplete. We recommend offering $60 for wolverine carcasses from SE AK for 2007-2008 not only to increase the number of carcasses collected, but also to build a museum collection of whole skeletons of wolverines from SE AK. Wolverines from SE AK are generally smaller than those from interior Alaska and a collection of skeletons would be useful for morphological studies of the SE AK wolverine.

RECOMMENDATIONS

Based on our pilot study, ARGOS/VHF collars and infra-red cameras show the greatest promise for obtaining information on distribution, movements, and habitat associations of wolverines in our study area. We recommend that future work on wolverines in our study area focus on collecting more information on movements and home range using ARGOS/VHF collars, particularly on adult females, and using camera trapping over a wide area to establish minimum population size and to examine distribution and habitat associations. A limited amount of hair snagging could be used to verify the sex of animals visiting baited sites. To examine the genetic relationship of wolverines in SE AK and adjacent Canadian provinces, we recommend additional collection of wolverine carcasses from trappers.

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FIGURES

Figure 1. Wooden live trap with trigger set. Wolverine photographed with a Stealthcam digital infra-red camera.

Figure 2. Damage to a live trap caused by a wolverine chewing around the lag bolts that attached the front of the trap to the sides and then pushing the front of the trap outward.

Figure 3. Culvert-style live trap with the door open.

Figure 4. ARGOS/VHF collar showing the ARGOS PTT antenna and the antenna for the VHF unit.

Figure 5. Vinyl pendants on nylon cord used for visually identifying wolverines that were not collared with ARGOS/VHF collars.

Figure 6. Hair snagging device with deer leg for bait

Figure 7. Run pole with hanging bait and wolverine looking up at the bait, showing the light coloration pattern on the chest, throat, and chin.

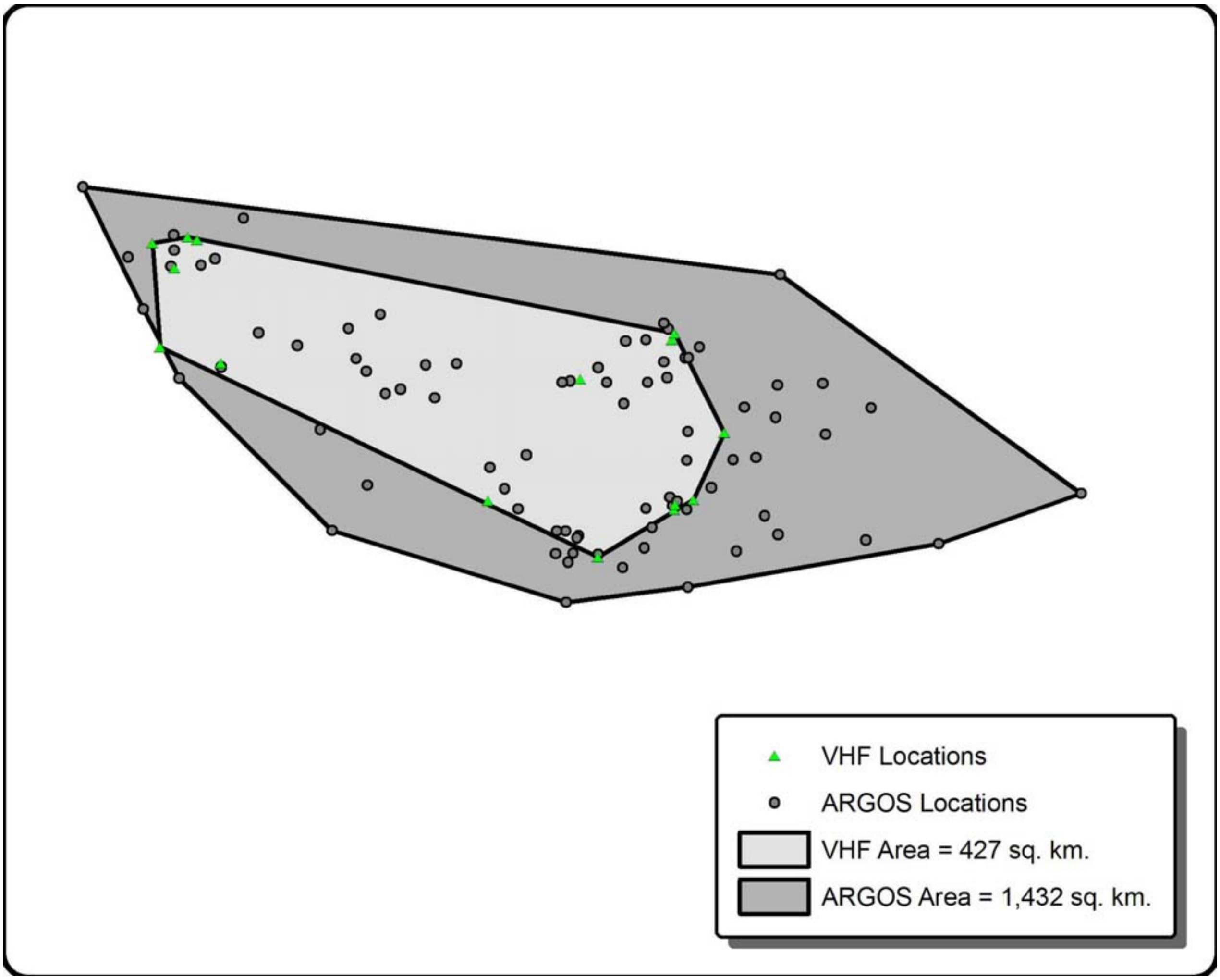

Figure 8. ARGOS and VHF locations of an adult male wolverine on the mainland of Southeast Alaska near Petersburg.

Figure 9. Pattern of light coloration on the chest, throat, and chin of 7 different wolverines photographed in the study area. The inset photos are the patterns of captured wolverine photographed while the animals were immobilized.