FEDERAL AID FINAL
RESEARCH PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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RESEARCH FINAL REPORT SHELL AND INSTRUCTIONS

The purpose of this report is to summarize significant findings and their management implications for the entire project. This summary will be used in a national Federal Aid database available to the public on the World Wide Web. A research final report can include the last annual performance report of a project, if desirable (section V.). This template is based on Federal Aid reporting requirements as found in the Federal Aid Handbook, Chapter 11 http://wsfrprograms.fws.gov/subpages/toolkitfiles/fah52211.pdf

PROJECT TITLE: Evaluating methods to control an infestation by the dog louse (*Trichodectes canis*) in gray wolves (*Canis lupus*)

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COOPERATORS: None

FEDERAL AID GRANT PROGRAM: Wildlife Restoration

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PROJECT NO.: 14.25

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STATE: Alaska

PERIOD: 1 July 2006–30 June 2013

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Ectoparasites can cause pathogenic effects on wild hosts (Wall 2007). Most commonly their direct feeding can cause skin damage and these wounds are vulnerable to infection. Some ectoparasites can act as vectors for other parasites and disease and indirectly harm the host by causing increased rubbing or scratching behavior resulting in reduced time feeding and possible self wounding (Wall 2007). Expanding human influences in wilderness areas has opened pathways for non-native parasites to be introduced (Sleeman and Gillin 2012). Development of effective monitoring techniques to assess impacts and management treatments to reduce detrimental impacts has become important in disease and parasite management across the world (May 1988, Gortazar et al. 2007), but treatment of wide-ranging wild hosts remains difficult (Sovell and Holmes 1996).

The biting dog louse (*Trichodectes canis*) is an obligate ectoparasite of canids (Tompkins and Clayton 1999, Durden 2001) and was first detected in Alaska (USA) on wolves (*Canis lupus*) on the Kenai Peninsula in 1981 (Schwartz et. al. 1983, Taylor and Spraker 1983). Infestations expanded north to the Matanuska-Susitna area in 1998 (Golden et al. 1999) and then to the middle Tanana valley of Interior Alaska in 2003 (Woldstad 2010). Schwartz et al. (1983) reported that dog lice were not identified on Alaska wild canid populations prior to 1981 but occurred at low-level enzootic on domestic dogs. Woldstad (2010) conducted a comprehensive statewide survey on occurrence of dog lice on wolves and concluded that the parasite was most likely introduced to Alaska via domestic dogs. Transmission of dog lice can occur through direct physical contact or use of denning and bedding sites (Durden 2001).

In Alaska, no direct mortality attributed to lice has been observed in wolves; however, it is likely that severely infested wolves have reduced fitness (Schwartz et al. 1983). Most wolves infested by dog lice in Alaska exhibit moderate to severe clinical signs of pediculosis including hair breakage, matting, irritation of the skin, and secondary bacterial dermatitis. Poor pelt condition reduces monetary and aesthetic value of wolves to trappers and wildlife viewers resulting in economic loss (Schwartz et al. 1983). Wildlife managers in Alaska predicted that dog lice infestations would continue to spread across Alaska and into Yukon, Canada because wolves disperse long distances and associate with other wolves (Taylor and Spraker 1983, Ballard et al. 1987, Mech et al. 1998). The Alaska Department of Fish and Game (ADF&G) decided to actively manage the dog lice infestation of wolves, since the parasite was an introduced parasite and could have long-term detrimental effects due to its severity and persistence.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

To identify dog lice infestations of wolves and coyotes (*Canis latrans*), ADF&G initiated a statewide monitoring effort in 1992 (Golden et al. 1999). This surveillance program was successful in alerting ADF&G of lice infestations of wolves in the Matanuska-Susitna area in 1998 and in the Tanana River valley in December 2003. ADF&G attempted to manage the dog lice infestations of wolves on the Kenai Peninsula and from the Matanuska-Susitna area during 1983 and 1999, respectively (Golden et al. 1999). Both projects relied primarily on capture and intramuscular injection of ivermectin and secondarily on wolves finding and consuming ivermectin injected baits at moose (*Alces alces*) kill sites. Ivermectin is a broad-spectrum antiparasitic drug that was originally developed for treating ectoparasite infestations in livestock (Campbell et al. 1983). When administered orally, subcutaneously, or intramuscularly at 0.4 mg/kg, ivermectin was effective in killing adult lice and nymphal stages on captive wolves, but not lice eggs which usually hatch in 7–10 days (Taylor and Spraker 1983, Jimenez et al. 2010). These results indicated that ivermectin could be effective in eliminating biting dog lice infestation on free-ranging wolves, but multiple treatments would be necessary due to resistance of eggs and the timing of egg hatch relative to the elimination of ivermectin in the bloodstream.

Management attempts in Alaska coincided when lice infestation was limited to a few wolf packs and was highly aggregated; however, both attempts to rid wild wolves of dog lice were unsuccessful. These attempts indicated that a treatment method conducted during the winter and relying primarily on capture and injection, as well as on wolves revisiting kills to find and consume injected baits, were inadequate to manage dog lice infestation on a population scale. Possible limitations were that not all infested wolves were fully treated to eliminate all life stages, or because wolves became reinfested through associations with infested coyotes or newly dispersing infested wolves once the effects of the treatment wore off (Golden et al. 1999).

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: <u>Determine extent of louse infestation in wolf packs in Game Management Unit (GMU) 20A using visual observations of live wolves, hide inspections of trapper-caught wolves, and wolf capture and collection</u>.

To determine the extent of lice infestation of wolf packs in GMU 20A, we inspected multiple wolves from 19 individual packs through live capture, pelts purchased from trappers, and observations during survey flights. We developed a treatment area within GMU 20A where all packs found infested were treated and a control area which included 1 infested pack in GMU 20A and 2 infested packs in GMU 20C that were monitored but not treated (Fig. 1). For all hide inspections, we used a 10× magnification loupe to visually inspect for signs of hair damage, skin lesions, and lice. Lice and associated skin lesions were most likely to be recognized in the groin area so a thorough inspection using additional artificial light occurred in this area. We also collected skin biopsies from along the midline between the shoulders and from the lateral thigh and groin areas with a 6 mm disposable biopsy punch (Miltex, Inc., York, Pennsylvania). The samples were examined microscopically by a veterinary pathologist for inflammation consistent with ectoparasitism. We conducted weekly to monthly aerial radiotelemetry flights and observed each pack at 90 m–100 m altitude to detect signs of lice infestations. Wolves with moderate to severe infestations can be identified from the air by obvious hair loss and incessant scratching (T. Spraker, ADF&G [retired], Kenai Peninsula, personal communication). We requested trappers to bring us wolves and coyotes that were harvested within the treatment and control areas regardless if we had previously sampled the pack. After a thorough visual inspection using a 10× magnification loupe, we purchased all pelts of both species that were suspected to be infested with dog lice. We verified presence or absence of dog lice by using potassium hydroxide (KOH) hide dissolution. This method was determined to have the highest sensitivity and specificity and would verify presence as low as 1 louse per wolf (Woldstad 2010).

During 2002–2005, we inspected 150 wolf hides harvested by trappers within the home ranges of 13 treatment area packs and verified that 2 packs (15%) were infested. The Grubstake pack was found to be infested in December 2003 and the Blair Lakes pack in December 2004. Both packs were inspected in previous years and were not infested. During 2005–2010, we examined 131 wolves for lice by visual inspection (62), histopathology (46), and by hide digestion (23). We also monitored 45 radiocollared wolves in 19 of the 20 known packs in the treatment area. During winter 2005–2006, 7 of the 14 (50%) monitored packs in Unit 20A were lice infested. We began treatment during summer 2006. Lice infestation declined from 50% of the packs in 2006 to 0% in 2009 following 3 years of treatment. We evaluated 12 suspect coyotes harvested within the treatment area, 8 by hide digestion and 4 by histopathology. None were infested.

OBJECTIVE 2: Determine efficacy of den/rendezvous site treatment to manage lice infection.

We attempted to orally administer ivermectin via baits to all members of wolf packs found to be lice infested within the GMU 20A treatment area. We monitored but did not treat the 3 control packs. As a precursor to this study, during April 2005, we captured, evaluated, and radiocollared all 5 members of the Blair Lakes pack, which was 1 of the 2 known lice infested packs in the studies treatment area. We treated each Blair Lakes wolf at capture with 200 µg/kg of ivermectin (Ivomec 1% injection for cattle and swine) by subcutaneous injection to kill the adult lice. We did not recapture these wolves to treat against a subsequent hatch of eggs which were observed, but instead aerially dropped ivermectin-injected baits from small aircraft (Piper PA-18 Super Cub, Bellanca Scout) at the den and rendezvous sites at 2-week intervals during June–August. During the study, our treatment scheme did not include capture and subcutaneous injection, only aerially distributed ivermectin-injected baits at den and rendezvous sites of infested packs every 10–20 days during May–August.

Our baits were partially-thawed fist-size chunks of moose or lynx (*Lynx canadensis*) meat injected with ivermectin. Ivermectin is 95% bioavailable with an elimination half life of 80.3 ± 29.8 hours (Gokbulut et al. 2006, Al-Azzam et al. 2007). Bait dosages varied throughout the summer and was based on average wolf weights by age (ad, pup) and the dosage given safely to wolves previously (albeit by intramuscular and subcutaneous injection) of 0.4 mg/kg (Taylor and Spraker 1983). The number of baits dropped at each den or rendezvous site was dependent on pack size and the availability and size of pups. We did not distribute adult dosages once the pups were mobile and potentially had access to an adult dose. During each treatment period, dosages were large enough that if an adult or pup wolf ingested one adult or pup bait, respectively, it would ingest the recommended effective antiparasitic dose (0.2 mg/kg; Barragry 1987, Gokbulut et al. 2006), but if it ingested all the baits it would be below neurotoxic levels (16 ad baits for a 38 kg ad wolf; 25 pup baits for a 4–5 week old pup). The toxic levels range from mild reactions at 5 mg/kg to death at 40 mg/kg with a median lethal dose at 80 mg/kg (Seward et al. 1986).

We completed 3 adult-treatments/pack/year during the onset of denning (early May) to 19 June. This period coincides to when pups were 0–4 weeks old and mainly in the den (Mech 1970). Ivermectin is excreted in milk in low concentrations and poses little risk to nursing offspring (Plumb 2008:682–684). The adult dose was 12 mg/bait. When distributing adult baits, we flew around midday to maximize the chance of encountering adults at the den or rendezvous site (Ballard et al. 1991).

After 19 June we no longer deposited adult dosages and reduced the dosage to safely treat pups as they began to emerge from the den (Mech 1970). During 19 June–5 July the dose was 1.5 mg/bait. We increased the dosage based on expected weight gain by pups to 1.8 mg and 2.0 mg during 15–31 July and 1–26 August, respectively (Mech 1970). We completed 4–5 pup-treatments/pack/year. During these periods when we were targeting pups, we visited sites during early morning because adults were more likely to be away from the den on hunting excursions (Ballard et al. 1991).

Vegetation type, density, and height varied between den sites and included knolls covered with low lying tundra, ridges with 1 m–10 m tall shrubs, and low lying areas with mixed forests of spruce (*Picea* spp.) and deciduous trees of moderate density. We attempted to drop baits near the den holes or around preferred resting areas. During each flight we recorded the number and color of adults and pups present to evaluate if all wolves in the pack had access to bait. We did observe adult and pup wolves eating baits but could not verify how many baits per wolf were actually consumed. We did not attempt to treat coyotes.

During December 2005, we evaluated the treatment scheme used during spring and summer 2005 on the Blair Lakes pack by capturing 4 pups and visually searching each wolf for lice using a 10× magnifying loupe. We also purchased the pelt and carcass of one of the pack members that had been caught by a trapper during January 2006 and used KOH hide dissolution to verify status. During 2006–2010, we assessed treatment effect by either collecting 1 pup or by purchasing wolf hides from trappers from all treated and untreated radiocollared packs in the treatment area as well from the 3 control packs. We obtained wolves from untreated packs in the treatment and control areas to monitor lice transmission and to determine reinfestation rates of packs previously treated. We used KOH hide dissolution to determine lice presence. We necropsied wolf carcasses to evaluate body condition, conduct gross and histopatholgical examination of organ systems and detect presence of intestinal macroparasites. We compared results of treatment effects on lice infestation between treated packs and the 3 control packs using Fisher's exact test (FET). We evaluated reinfestation rates using a single sample test of proportions (Scott and Seber 1983).

All treated packs were lice-free during the winter following treatment and remained lice-free ≥15 months. In comparison, all 3 control packs remained continuously infested for 4 consecutive years (Table 1). Given that a pack was lice infested, the chance of lice being present the following winter after treatment was 0% ($n = 9$) and significantly less than packs not treated (100% infested, $n = 3$) ($P = 0.005$, FET). The untreated control pack in the treatment area that had lice during 2005–2008 was removed by harvest prior to denning during winter 2008–2009. The vacant home range was usurped by the adjacent Gold King (never treated) and Buzzard Creek (treated in 2006) packs. Although both of these packs were lice-free when this occurred, the Buzzard Pack had been infested prior to treatment in 2006 (Fig. 1).

Following treatment, the proportion of packs remaining lice-free (89%) was significantly different to the proportion of packs (11%) that became reinfested ($p_{re\text{-}infested} - p_{lice\text{-}free} = -0.78$; 95% CI = −1.19, −0.37; $n = 9$, single sample test of proportions). The single pack that became reinfested was Blair Lakes, which was originally treated in summer 2005. We verified it as lice-free by observation and KOH dissolution during December 2005, January 2006, and November 2006. We captured 2 pack members (≥23 months old) during April 2007, 15 months after treatment and found them to be infested. We documented inter-pack strife during November 2006 and December 2006 with 2 known lice-free packs (Iowa and Wood River Butte). In both instances, 1–3 Blair Lake wolves were killed including the dominant male in November 2006 and dominant female in December 2006. Following the December skirmish, 2 yearling wolves from the lice-free Wood River Butte pack (both radiocollared) joined the Blair Lake pack. However, based on pack numbers and wolf colors observed during subsequent radiotracking flights, 2 additional wolves of unknown origin also joined the Blair Lakes pack in January 2007. This was the only case of reinfestation; the other treated packs remained lice-free for ≥3 years following treatment.

We found no evidence that without treatment, wolves could spontaneously rid themselves of lice or develop innate immunity within the time span of the study; all 3 control packs remained infested throughout the study and lice have persisted in wolf packs on the Kenai Peninsula and in the Matanuska-Susitna area for 13–30 years. However, treatment success can be temporary and reinfestation is possible. During our study, reinfestation occurred during the period when lice were still common in packs in the treatment area. Reinfestation did not occur once the local source population was eradicated but remains a possibility due to distant wolf dispersal and from coyotes.

OBJECTIVE 3: Establish rate of transmission between packs.

We did not collect the detailed information necessary to determine how fast lice could be transmitted between pack members. Observations made during this study and results from studies on the Kenai Peninsula (Schwartz et al. 1983) and Matanuska-Susitna area (Golden et al. 1999), suggest that all wolves in a pack once exposed to lice became infested within a year; every wolf either harvested or live handled from an exposed pack had lice within this time period.

We evaluated wolf dispersal, pack removal, and dominant wolf survival rates on lice transmission between packs by monitoring the 45 radiocollared wolves in 19 packs within the treatment area. For all analyses, we defined the biological year as 1 May–30 April, closely coinciding with pup production (Adams et al. 2008). As radiocollared wolves dispersed from their natal areas, we attempted to monitor these wolves to determine the type of dispersal and the outcome. We categorized dispersals as either local (wolves left their natal range but remained within the study area) or long range (wolves left the study area; Adams et al. 2008). If we lost contact with dispersing wolves, we broadened our search outside the study area and asked other biologists conducting radiotelemetry studies in other areas of Interior Alaska to help locate the dispersing wolves to determine their fate. We estimated age-specific dispersal rates and dominant wolf survival using a Kaplan-Meier staggered-entry design for telemetry studies (Pollock et al. 1989).

Of the 45 radiocollared wolves, 16 dispersed from their original packs. Two of these settled with packs (1 local and 1 long distance) but subsequently dispersed again (both long distance) after spending 4 and 21 months with their adopted packs. In total, there were 9 local and 8 long distance dispersals. Annually, 24% (95% CI = 0.15–0.33) of the radiocollared wolves dispersed from packs they were associated with during the previous 4 months. Dispersal occurred throughout the year but most wolves dispersed during

January–April (10 of 17) and few (2 of 17) during the treatment period (mid-May through mid-August). Dispersal rates decreased with increasing wolf age, except that no wolves (*n* = 9; 639 days at risk) dispersed prior to 12 months of age. Of 4 >3-year-old wolves that dispersed, 3 formed breeding pairs in the treatment area and 1 emigrated. Two packs were formed during the study by local dispersal, which increased the number of known packs from 18 to 20 in the treatment area. Over the course of the study, 12 of 16 dispersers had some contact with packs that had been infested but treated prior to dispersal (including the 2 dual dispersers).

Avenues for dispersers to become established within the treatment area occurred when entire packs were eliminated and when dominant wolves died. Territories of 3 radiocollared packs (Clear Creek Butte-2006, Benches-2007, and Forgotten-2008) and 1 pack that was not radiocollared (Grubstake-2008) were vacated when all pack members either dispersed or died. One of the territories was settled by a radiocollared local disperser, 1 by territorial expansion of 2 local adjacent radiocollared lice-free packs, and 2 by lice-free packs that were unmarked and of unknown origin (based on pelt examination of captured wolves and trapper-caught wolves). The annual survival rate for dominant wolves (*n* = 28, *n* = 18,360 days at risk) was 0.75 (95% CI = 0.651–0.838).

In our study area, prior to treatment, dog lice infestation rates were rapid. We found that if there is a local population of enzootically infested wolves, neighboring packs were more vulnerable to infestation due to local dispersing wolves. Local dispersal was common in our study area and probably was the cause of apparent initial increase in prevalence rate and in contrast, the reason for lower prevalence rates once the local source population of lice was removed. Of the 16 dispersing wolves in our study, we verified that ≥12 joined or formed packs, 9 of which were associated with infested packs but were treated prior to dispersal. Furthermore, dispersing wolves can join ≥1 pack (Fuller 1989, this study) and potentially infest multiple packs. In most instances local dispersers require an open breeding slot to settle suggesting that infestation rates would be higher in heavily exploited populations with vacancies created through removal of dominant wolves or entire packs (Packard and Mech 1980).

We surmised the primary causes of reduced infestation and reinfestation rates following treatment were 1) identifying and treating packs within a year of infestation, 2) successfully eliminating the source population of lice from the area, and 3) few successful long distance immigrants to the area due to few territory or breeder vacancies and local dispersal. By initiating treatment promptly after detection, fast transmission to unexposed nearby packs at a time when conditions for transmission was apparently favorable was stopped. Within 3 years, we were able to eliminate lice from the treatment area. Once the local source population of lice was eliminated, none of the 19 monitored packs became infested over the last 3 years of the study. Furthermore, within the treatment area open breeding slots were limited and when available, were mostly filled by local dispersers. We documented that most of the new pack formation in the treatment area was due to local dispersal, rather than long distance immigration.

OBJECTIVE 4: Determine if lice-infected packs have lower productivity and survival rates.

We did not pursue this objective during the study due to funding constraints.

IV. MANAGEMENT IMPLICATIONS

Managers can reduce dog lice infestations of wolves through repeated treatments of ivermectin-injected baits at den and rendezvous sites. Initiating multiple treatments promptly after detection when lice infestation is limited, transmission to unexposed nearby packs can be stopped and the local source population of lice on wolves eradicated. If this protocol is followed, lice resistance to ivermectin should be limited because baits are restricted to a discrete area and each dose is sufficient to rid an individual wolf of lice. Effective management requires identifying infested packs and locating their den and rendezvous sites. Once infested packs are successfully treated and the parasite is locally eradicated, transmission rates will decline significantly. However, ivermectin treatment does not infer immunity and reinfestation can occur. Wolves are efficient vectors of this parasite because almost all wolves disperse, can move long distances, and potentially associate with multiple packs (Fuller 1989; Gardner et al. this study). Consumptive users will likely be the most impacted group when evaluating the consequences of poor pelt quality due to lice infestation. In severe cases, hunters and trappers may reduce their take of wolves, which in turn will have negative consequences for management programs that rely on public wolf harvests. In our study area our annual costs to capture or collect wolves, identify lice infestations, treat, and monitor success was \$30K–\$35K (U.S. dollars). Costs will be higher for projects that are solely limited to commercial aircraft.

V. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY

JOB/ACTIVITY 1: We conducted biweekly literature searches for manuscripts on parasite transmission and management and on wolf population dynamics and behavior that may cause greater vulnerability to lice infestations.

JOB/ACTIVITY 8: We completed a manuscript entitled “Experimental Treatment of Dog Lice Infestation in Interior Alaska Wolf Packs” that was published in the *Journal of Wildlife Management* (see separate pdf submitted with this report).

VI. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THE LAST SEGMENT PERIOD, IF NOT REPORTED PREVIOUSLY

None.

VII. PUBLICATIONS

See separate PDF submitted with this report:

GARDNER, C. L., K. B. BECKMEN, N. J. PAMPERIN, AND P. DEL VECCHIO. 2013. Experimental treatment of dog lice infestation in Interior Alaska wolf packs. Journal of Wildlife Management 77(3):626–632.

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VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

None.

IX. APPENDIX

See separate PDF submitted with this report:

GARDNER, C. L., K. B. BECKMEN, N. J. PAMPERIN, AND P. DEL VECCHIO. 2013. Experimental treatment of dog lice infestation in Interior Alaska wolf packs. Journal of Wildlife Management 77(3):626–632.

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DATE: 8 August 2013

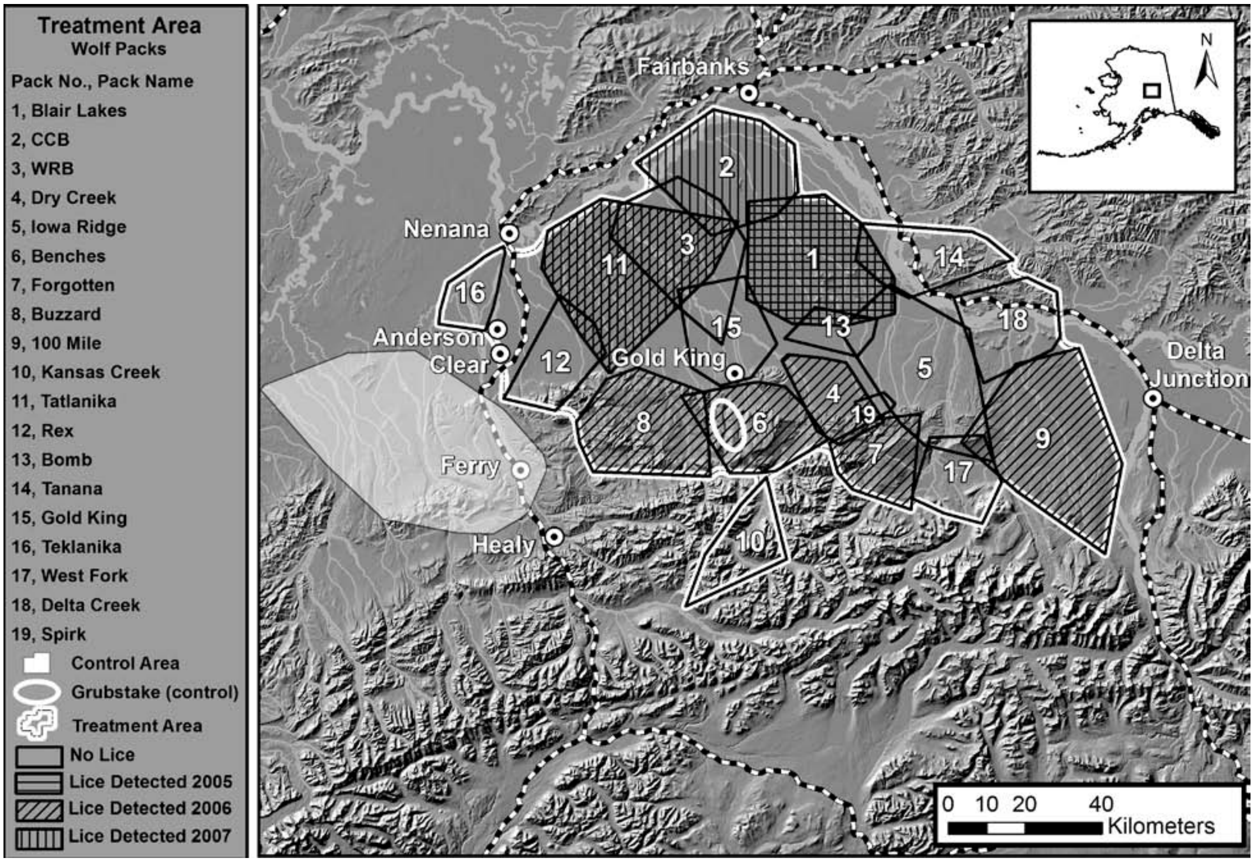
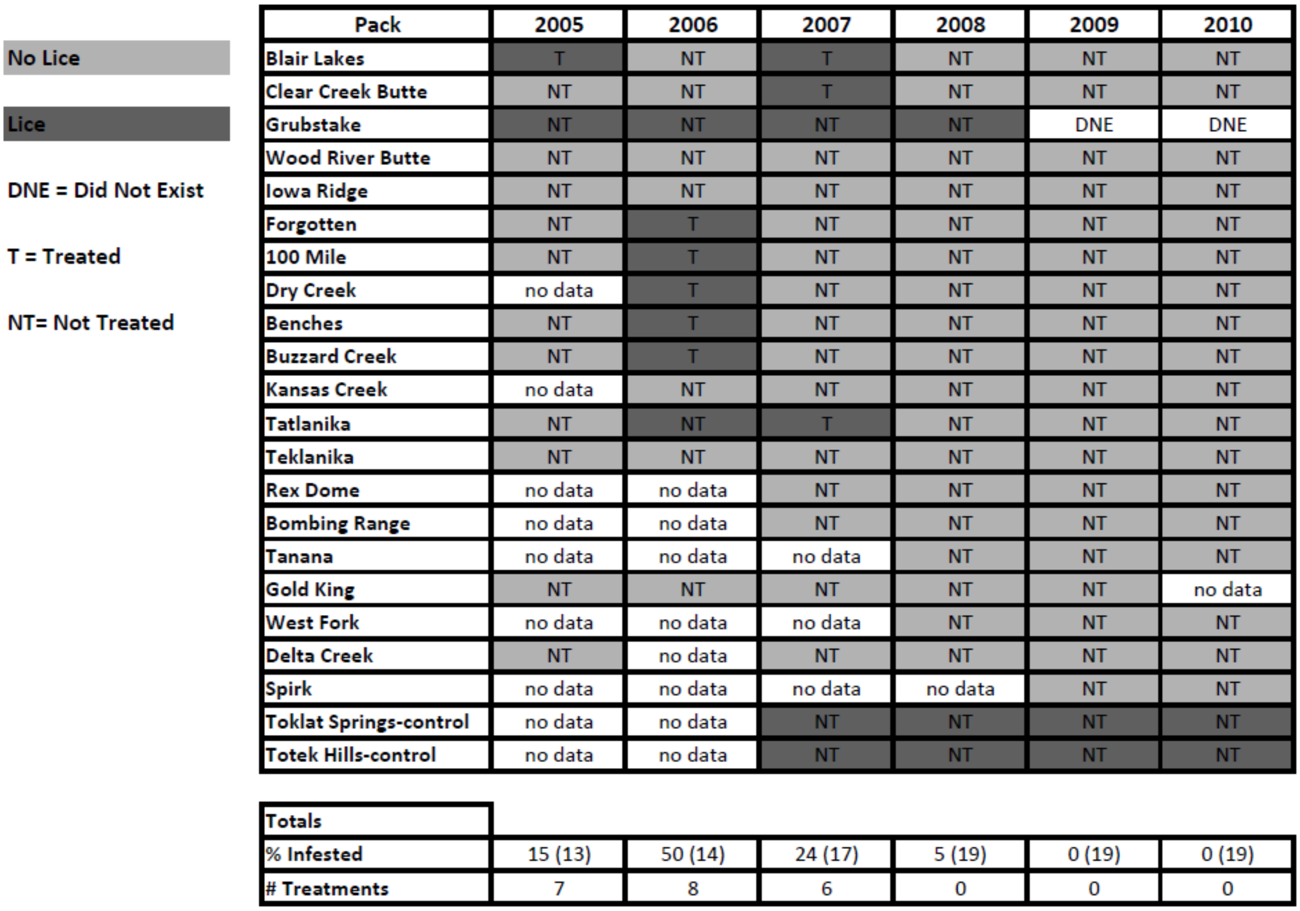


Figure 1. Wolf treatment and control study areas and pack territories with lice history in Tanana Flats, Interior Alaska, USA, April 2005–April 2010.

Table 1. History of lice infestation of wolf packs in the Tanana Flats, central Interior Alaska, USA, April 2005–April 2010. We confirmed presence or absence of dog lice using histopathological verification of skin biopsies and potassium hydroxide hide dissolution. Treatment occurred during May–August 2005–2007.



No Lice

Lice

DNE = Did Not Exist

T = Treated

NT= Not Treated

Pack	2005	2006	2007	2008	2009	2010
Blair Lakes	T	NT	T	NT	NT	NT
Clear Creek Butte	NT	NT	T	NT	NT	NT
Grubstake	NT	NT	NT	NT	DNE	DNE
Wood River Butte	NT	NT	NT	NT	NT	NT
Iowa Ridge	NT	NT	NT	NT	NT	NT
Forgotten	NT	T	NT	NT	NT	NT
100 Mile	NT	T	NT	NT	NT	NT
Dry Creek	no data	T	NT	NT	NT	NT
Benches	NT	T	NT	NT	NT	NT
Buzzard Creek	NT	T	NT	NT	NT	NT
Kansas Creek	no data	NT	NT	NT	NT	NT
Tatlanika	NT	NT	T	NT	NT	NT
Teklanika	NT	NT	NT	NT	NT	NT
Rex Dome	no data	no data	NT	NT	NT	NT
Bombing Range	no data	no data	NT	NT	NT	NT
Tanana	no data	no data	no data	NT	NT	NT
Gold King	NT	NT	NT	NT	NT	no data
West Fork	no data	no data	no data	NT	NT	NT
Delta Creek	NT	no data	NT	NT	NT	NT
Spirk	no data	no data	no data	no data	NT	NT
Toklat Springs-control	no data	no data	NT	NT	NT	NT
Totek Hills-control	no data	no data	NT	NT	NT	NT

Totals						
% Infested	15 (13)	50 (14)	24 (17)	5 (19)	0 (19)	0 (19)
# Treatments	7	8	6	0	0	0