Development of a Passive-capture Technique for Radiotagging Large Animals

Research Final Report
1 July 2001 – 30 Sept 2002

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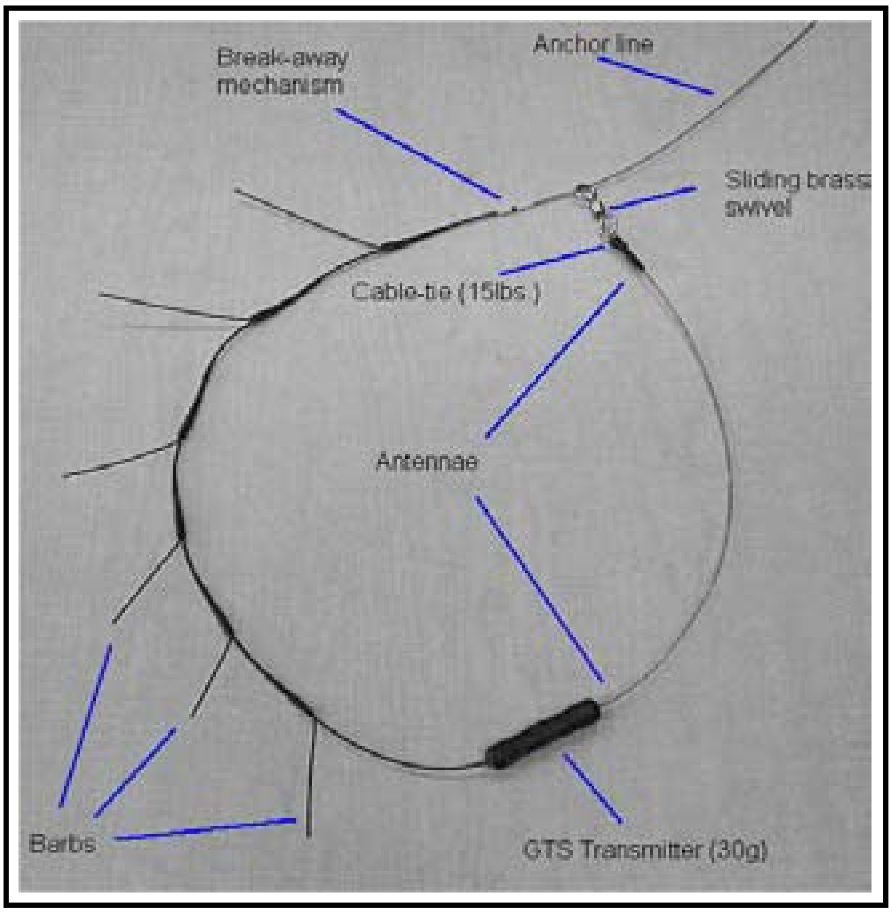
Alaska Department of Fish and Game
Division of Wildlife Conservation



ADF&G

Federal Aid in Wildlife Restoration
Grants W-27-5 and W-33-1
Project 15.10
December 2002

STATE OF ALASKA

Frank H. Murkowski, Governor

DEPARTMENT OF FISH AND GAME
Kevin Duffy, Acting Commissioner

DIVISION OF WILDLIFE CONSERVATION
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FEDERAL AID
FINAL RESEARCH REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

PROJECT TITLE: Development of a passive-capture technique for radiotagging large animals.

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COOPERATORS: Kurt Aluzas (USFS, Wrangell), Richard Lowell (ADF&G, Petersburg), Rocky Mountain Elk Foundation

FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NR: W-27-5 and W-33-1

PROJECT NR: 15.10

WORK LOCATIONS: Douglas Island, Prince of Wales Island and Zarembo Island in southeastern Alaska

STATE: Alaska

PERIOD: July 1, 2001 – June 30, 2002 (W-27-5) July 1, 2002 – Sept. 30, 2002 (W-33-1)

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Radiotelemetry is a key component of most federal aid research projects in Alaska. Affixing radiocollars to large mammals, such as moose (*Alces alces)*, caribou (*Rangifer tarundus*), Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), mountain goats (*Oreamonos americanus*), brown bears (*Ursus arctos*), black bears (*Ursus americanus*), and wolves (*Canis lupus*) requires active capture of the animal. This is usually accomplished using a helicopter as a platform, and firing a dart or net at the animal to chemically immobilize or physically restrain it. Active capture has relatively high associated costs. Moreover, the process of active capture may lead to animal exhaustion, injury, and even death (Conner et al. 1987, Beringer et al. 1996, DeNicola and Swihart 1997).

In some regions of the state, notably southeastern and southcentral Alaska, it is difficult to radiocollar an unbiased sample of the population because the study animals are often hidden beneath forest cover. Active capture from the air is impossible. Animals may be captured from the ground with immobilizing darts, drop nets, or clover traps, but all of these methods are either labor intensive, have low encounter rates, require continuous monitoring, or have high set up and logistical costs. If an animal can be passively collared, the costs, constraints, and biases associated with active capture are greatly reduced.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS

Self-attaching collars provide a promising solution for radiotagging and individually marking animals in a manner that is inexpensive, safe, possible in thickly forested environments and is not subject to spatial capture bias. The use of self-attaching collars for marking large mammals was first described by Romanov (1956) and used on a variety of wildlife species in the boreal forests of Siberia. Studies throughout the 1960s introduced various innovations and generally focused on ungulate species (Verme 1962, Siglin 1966, Taylor 1969, Clarke and Henderson 1978), though other species have also been collared (Keith 1965, Beale 1966). Overall, collaring efforts were generally quite successful and in most previous studies over 50% of deployed collars were eventually attached to target animals (Appendix, Table 1).

Past collaring efforts were initiated in order to mark animals using distinct color combinations and thus enable identification of unique individuals. Typically such data were used to gain information about animal movement patterns, but this required subsequent observation of the animal at close range, which was difficult. With the development of radiotelemetry techniques in the 1960s (Cochran and Lord 1963, Tester et al. 1964), study animals could be tracked from the air or ground at a distance. This method, however, required handling the study animals to fit and attach relatively bulky radiocollars. Snare marking techniques were abandoned, and research emphasis turned to new, more effective means of immobilizing and handling animals. In this study we take advantage of the recent advances in transmitter miniaturization, and combine that technology with older snaring techniques to develop a break-away snare with a miniaturized, inconspicuous radiotransmitter. This technique could become widespread where animals must be radiocollared efficiently and non-intrusively in areas or habitats that are difficult to access.

<u>Field Trials, Etolin Island</u>:

Prior to the beginning date of this grant project we had begun exploring the use of self-attaching collars as a tool for investigating competitive interactions between deer and elk. On 15-16 March 2001, we deployed 25 snare collars with expansion segments on Etolin Island. Etolin was selected because elk were successfully introduced here in 1987. Fifteen of the 25 collars utilized shielded surgical tubing (latex) for the expansion segment, and 10 utilized a bungee cord. All 25 collars had a single barb, or y-catch, sized appropriately for the average neck circumference of Roosevelt elk.

The collars were hung along game trails in the beach fringe timber, in areas that elk appeared to concentrate. Elk use was judged by abundant pellet groups and evidence of heavy browsing. All snares were below 100 feet elevation, and within 100 m of the beach. Snares were hung from surrounding trailside vegetation using thin 20g copper wire to hold the loop in a circular or rectangular shape. The anchor cable for the snares was firmly attached to a nearby tree with fence staples. We recorded the height from ground level to the lowest point on the snare loop, as well as the width and height of the snare opening. The average height of the snare set from the ground to bottom of loop was 121.9 cm (+/- 63.6 cm, 95% CI). The mean height of the snare opening was 67.1 cm (+/- 8.5 cm, 95% CI).

The mean width of the snare opening was 86.1 cm (+/- 10.3 cm, 95% CI). We took care to camouflage the transmitter and snare cable with small branches, and in some case laid slash alongside the trail to help funnel animals through the set. Transmitters were set to transmit for 12 hours per 24-hour day.

The collars were checked on April 15th, after being deployed for 1 month. Aerial tracking indicated 23 inactive, 1 active (presumably on an animal), and 1 missing transmitter. We landed and inspected 17 of the snare sets from the ground. Seven of the 17 (41%) had been encountered or disturbed. Of those, 4 were down, but had not cinched past the barb. Three had cinched past the barb and broken free, but had not been successfully attached to an animal. These 7 were picked up. One month later (17 May), the snares were again checked. Of 11 visited, 7 had been disturbed. Of these, 4 had been knocked down but not cinched past the barb, 2 were down and cinched past the barb, and 1 was missing. All 10 found collars were retrieved. On July 23rd, the remaining 6 collars at McHenry Anchorage were retrieved. Of these, 4 were knocked down but not cinched past the y-catch, 1 was knocked down and cinched past the y catch, and 1 collar was missing.

The Etolin field test results were discouraging. Of 25 snares set, encounter rates were relatively high (84%), but no animals were confirmed as successfully collared. Forty-four percent of the snare sets were simply brushed aside or knocked down, and 28% were cinched down, but did not stay on the animal. Three of the collars (12%) were missing, and one may have been on an elk temporarily. This signal was not detectable in May; and the other two missing snares probably have malfunctioning transmitters, as their signals have never been heard.

The surgical tubing showed evidence of degradation after 1 month of exposure to UV light and the elements, especially where it was stretched around collar components. The reasons for the lack of success can only be surmised, but we suspect the stretch built into these expandable snares prevented them from cinching down properly on the animals' necks. This feature represents the main difference between our collar design and previous designs that showed greater capture success. Accordingly, with the commencement of this grant project, we turned our attention to redesigning the collars to eliminate the expansion segments.

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

OBJECTIVE 1: Develop a break-away collar that is durable, lightweight, secure, and safe for a variety of wildlife species, specifically deer, elk and wolves.

We designed and tested several different types of collars, similar in concept to those previously developed and reported by others (Romanov 1902, Verme 1962, Taylor 1969, Clark and Henderson 1978). The collars designed for this study, however, incorporated a self-sizing feature along with a lightweight radiotransmitter.

Self-sizing collars employ a sliding loop that moves over a series of "catches" that work like a one-way zipper (see appendix for design diagrams). The collar relaxes by several inches after breaking free, to ensure a comfortable but not-too-tight collar fit. Should the collar be placed on a young animal whose neck can be expected to grow much larger, the collar has a plastic loop incorporated in the design that provides a weak breaking point (15 pound test). The plastic loop also degrades in UV light, meaning the collar should eventually fall off the animal. We did not test the UV sensitivity or durability of this feature, but expect the lifespan to be on the order of 1–3 years.

Construction diagrams of the self-sizing version of the snare collar are included in the appendix (Appendix, Figure 1).

OBJECTIVE 2: Design a durable, lightweight (< 50 g) radiotransmitter that can be attached securely to the snare collar. The transmitter should transmit on standard frequencies (150.00-152.00 MHz), have a range of > 20 miles (line of site), incorporate a mortality function, and have a life expectancy of > 2 years.

We solicited bids from 8 companies for transmitters that were small, powerful, long-lasting, and inexpensive. Specifications were: < 40g, < 80 mm length and 15.8 mm diameter, waterproof, on/off reed switch, > 50 bpm (live mode), > 100 bpm (mortality mode), > 15 ms pulse duration, and > 15 km range (line of site). Transmitters were purchased from the following companies for testing and evaluation: Telonics, Advanced Telemetry Systems, Global Tracking Systems, AVM Instrument Company, and Biotrack Ltd.

We determined the best size-performance-cost combination was provided by Global Tracking Systems (GTS). This company manufactured the least expensive ($177.00) and second smallest transmitter (22 x 68mm, 30g) that met or exceeded our performance specifications. The original transmitters initially had a very thin whip antenna that was subject to breaking, and had to be encased within some protective tubing on the collar itself. The second generation of transmitters from GTS increased the antenna to 1/16” diameter, allowing the antenna to function as part of the collar itself. GTS has since begun making and marketing these transmitters and snare collars independently.

OBJECTIVE 3: Develop and test snare-setting methods that yield high collaring rates for deer, elk, and wolves in various study areas in Southeast Alaska.

The first requisite for successfully collaring animals with a passive collaring technology rests on finding areas with a high concentration of use (Verme 1962). In order to meet this requirement, field surveys were conducted to identify areas of high animal use. Areas were searched for fecal pellet groups of deer and elk, or, in the case of wolves, previous radiotelemetry data were used to delineate pack core use areas. Once high-use areas were identified, specific locations for collar sets were determined by locating micro sites that had a natural tendency to funnel animals thru a particular set (e.g., down trees, slash, topography etc.). In some cases, sites were modified using small logs and branches that were cut and placed to influence the animals’ movements.

Once suitable sites were identified, we used information relating to animal chest height and neck circumference to position collars to maximize the chance that animals would encounter collars in a manner that would enable effective operation of the self-attaching mechanisms. For elk, we set collars high enough to minimize the likelihood of collaring other non-target species such as deer and wolves.

Field trials, Douglas Island

On July 31, 2001 we deployed 4 snares of a new design on Douglas Island for Sitka black-tailed deer (*Odocoileus hemionus sitkensis*). These snares utilized a series of barbs or catches that would allow the loop to close to a smaller diameter for small animals and a larger diameter for large animals. Because the neck size between male and female deer does not differ as much as neck size between male and female elk, the sizing of these collars was more uniform. On these collars we also experimented with a different break-away mechanism. The end of the snare cable was threaded into the middle of a ½ inch hollow-braid polyethylene line. A length of 35 pound test Dacron fishing line was tied around the first y-catch on the snare, and the other end was sewn into the hollow-braid line. The hollow-braid line was then tied to the tree, and thus, replaced the anchor cable in the previous design. This design allowed the swivel to slide easily down the hollow-braid line onto the snare cable and over the barbs. When the animal pulled away, in theory, the line would hold until a 35 pound breaking strength was reached. A primary disadvantage of this system was that it took longer to make the snare, and also the polyethylene line was much thicker and more visible than the steel cable.

These 4 snares were set in the forest, along game trails, at higher elevations where deer sign was slightly more abundant. Snares were set between 250 and 500m elevation. Height to the bottom of the snare loops was 82.6 cm (+/- 18.8 cm, 95% CI). Loops were roughly circular in shape, with an average diameter of 44.5 cm (+/- 7.9 cm, 95% CI).

After 3 months, 3 of the 4 collars were retrieved undisturbed. A fourth snare collar was not transmitting, and could not be found. This snare was found by a hunter in November 2002 and turned into the office. It had apparently been hit by a deer, was cinched down, and then fell off very near the spot where it had been set. We believe the snare was likely encountered by a buck, the antenna got hung up in the antlers before slipping to the ground. The transmitter was non-functional.

The poor success on Douglas Island can be attributed to the relatively low deer density on the island, the lack of trails or concentrated use areas in the woods, and possibly the high visibility of the polyethylene anchor line. Unlike elk, which spent considerable time on shore (at least in winter), deer appear much more dispersed across the landscape. Even so, with sufficient numbers of snares, and higher deer populations, good success might be anticipated.

Field Trials, Zarembo Island:

Between March 21-April 4, 2002, 31 self-attaching collars were deployed on the west side of Zarembo Island. All collars were set within 500m (most within 50m), of the beach. Following preliminary surveys of suitable habitat on the island, these areas along the beach fringe had the greatest concentration of elk sign. We were able to maximize the probability of elk encountering collars by working in these areas. Collars were set along previously used elk trails and, generally, set between 2 trees or other natural features that had a natural tendency to funnel elk towards such collar sets. Collars were set an average of 108.0 cm from the ground. The dimensions of the collar at each set were an average of 70.6 cm tall and 65.5 cm wide.

Field monitoring efforts were completed on 15 September 2002. The results of these follow-up trips have been largely disappointing and collar success rates were substantially lower than other studies (Appendix, Table 1). Of the 31 collars originally deployed, 22 were encountered by elk or other animals and had either been taken some distance from the site or were otherwise disturbed. Of these 22 collars, 4 were attached to animals (3 on elk and 1 on a wolf), 12 were not attached to animals, 1 has a faulty transmitter and 5 were unaccounted for and believed to have dead batteries. Several of these collars have been recovered in the field and provided insight into the mechanical performance of the collaring mechanism. Sixteen of 22 collars successfully broke away. Of the 6 that did not break away, they were either bumped or otherwise not fully contacted by passing animals. For 12 of the collars it was possible to assess how the adjustment mechanism operated, of these, 11 were cinched down, or adjusted properly, 1 was not.

Overall, these results indicate that the mechanical components of the collar were, generally, working properly; collars were breaking away and adjusting when encountered. Unfortunately, evidence indicates that collars were not affixing to elk as expected. Information leading to reasons why elk have not been collared is limited but possible explanations might include, 1) collars were encountered by non-target animals for which they were not designed to capture such as deer, 2) collar dimensions and height of the sets were inappropriate, or 3) the locking, or permanent attachment mechanism is not sufficient to keep the collar on the animal once it is originally affixed.

Field Trials, Prince of Wales Island

In conjunction with a different research project, Dave Person and Amy Russell experimented with a similar break-away radiocollar snare. The construction identical to the fixed length collars used on Zarembo Island, except that a single barb was used since there is little sexual dimorphism in wolves, and seasonal changes in neck size of canids is minimal. Eighteen snare collars were deployed on Prince of Wales Island during 2001 and spring 2002 on well-traveled wolf trails. Methods for hanging the snares were similar to those used for deer and elk, but with loop size and height adjusted differently. Of the 18 collars deployed for 2 months, 11 were encountered or disturbed by animals (61%). One collar was on a black bear for 1 month. Another collar has been on a deer for approximately 1 year.

OBJECTIVE 4: Develop and test a data logger that will remotely record and store information on deployed transmitters. Stored data will include time, date, direction, and strength of signal. The device should also be capable of recording date and time of non-radioed animals that break a laser or infrared beam directed across a nearby trail or open area.

In order to remotely record presence of radiocollared and non-radiocollared animals in discreet areas we acquired and field tested two separate, complementary devices. The first device, TX data logger (GTS, Sylvan Lake, AB), was designed to remotely record the presence of radiocollared animals within a small localized area. Records of animal visitation (for up to 250 distinctly radiotagged animals) can then be downloaded with portable PC computers in the field every 60–90 days. The second device, TRAFX data logger (Advanced Monitoring Systems, Canmore, AB), consisted of a remote-controlled camera electronically connected to an infrared beam and data logger. This device was designed to record and photograph a specified area every time the infrared beam was disrupted (i.e. by a passing animal). These data, too, could be downloaded in the field using a portable PC computer. Arranged together at a specific site, the TRAFX and LogFX data loggers have the capability to count and photographically document all animals in a specific locality and, further, determine whether such animals are radiocollared and if so, record their unique radio frequency.

TX Data Logger Testing: Lowrie Island, 3-6 August 2002.

Test 1: Effect of distance on data logging.
TX data logger was programmed to detect signals from 3 transmitters at 1-minute intervals. The data logger was deployed on a rock outcrop on a rocky beach overlooking ~110m of unobstructed beach. One transmitter was placed next to the data logger to serve as a baseline for signal strength (Telonics transmitter 150.640). Two other transmitters (GTS transmitter 150.131, ATS transmitter 150.854) were carried down the beach and 3-minute stops were made every 10m to allow for signal detection. The ATS transmitter emitted a stronger signal than the GTS transmitter, and was detectable up to 90m away, but the signal was inconsistent beyond 50m. The GTS transmitter was not detectable beyond 10 meters away.

Test 2: Ability to detect movement relative to a central location.
TX data logger was programmed to detect signals from 1 transmitter (ATS transmitter 150.854) at 1-minute intervals. The transmitter was moved 50–200m from the data logger for variable time periods. The data were effective in describing the trip lengths and time periods accurately, although signal strength was weak at greater distances.

In the trials described above, the TX data logger performed adequately though a few weaknesses were identified. Below, we summarize the strengths and weaknesses of the equipment and offer some suggestions for increasing the utility of the technology.

Strengths: The TX data logger was able to document use of discrete areas (0–90m) and thereby enable interpretation of use patterns of sites as well as temporal patterns of excursion of a central place. This application will be useful for studies in which researchers wish to document presence or absence of specific locations such as wolf dens, elk trails, or pinniped haulouts. Further, it may be possible, though the establishment of telemetry arrays, to decipher patterns of larger scale space use of animals.

Weaknesses: Testing indicated that the TX data logger has a small detection range such that under optimal conditions the most powerful transmitter was detected at distances no greater than 90m. This small range will limit the utility of the data logger to only very specific situations. It should also be possible for the manufacturer to increase the sensitivity significantly, making it suitable for different applications in the field.

Another weakness relates to problems with frequency data logging itself. Specifically, dummy frequencies (ie. frequencies not present in trials but programmed into the data logger as a check) were often logging signal strengths as if such frequencies were active even though they were not. Such frequencies should have been logged as null (-148 dBm). This may be attributable to a bandwidth sensitivity problem such that dummy frequencies were picking up signals from other deployed transmitters.

Recommendations:
1. Enlarge detection range to 500–1000m or, ideally, offer programming capability to adjust detection range. This should be possible due to capabilities of standard receivers to detect transmitters at distances 500m–5km.

2. Expand scanning time interval options from 1–60 minutes to hourly or daily scanning options. Further, include a feature that would perform 3 simultaneous scans per interval to allow for signal variation and enable more accurate information on animal presence or absence.

3. Independent scans for multiple antennas. For example, it would be ideal to have a 4-antennae array at each data logger to enable directional detections. Setting loggers of this type in different locations would allow for accurate triangulation of transmitter locations.

OBJECTIVE 5: Monitor tagged animals periodically over the year by air and ground visits to document transmitter, data logger, and collar performance. Data will include tagging success rates, number of non-target species tagged, and any injuries or mortality to tagged animals.

Because few animals were successfully collared, monitoring efforts were minimal. All functioning collars have been retrieved from the field and no monitoring is being done in conjunction with this job.

OBJECTIVE 6: Summarize findings in technical report or peer-reviewed publication, as results dictate.

No manuscripts will be submitted for publication unless further testing of these transmitters meets with greater success.

IV. MANAGEMENT IMPLICATIONS

Self-collaring snares are most useful in situations where there is forest cover, where there is high use of known trails (e.g., deep snow), where animals occur at reasonably high densities (leading to high snare encounter rates), where the investigator has good knowledge and experience with locating and setting snares, and where access is convenient. The technique is not amenable for antlered animals (or during seasons when antlers are present), and it is not useful if additional information on body size and condition of the animal is needed for the study. We believe the method has greatest utility for studies that focus on survivorship. Although our success rates were low, we believe the technique warrants further experimentation by others. The technique has potential to radiocollar animals efficiently, inexpensively, and with minimal intrusiveness to the animal.

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

This report covers research activity in two segment periods, July 1, 2001 – June 30, 2002 (W-27-5) and July 1, 2002 – Sept. 30, 2002 (W-33-1). During the first segment period work was completed on all of Objectives 1, 2, 4, 5, and 6 and for most of objective 3.

During the second segment period, field monitoring of the Zarembo Island elk portion of objective 3 was completed.

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

No other unplanned federal aid-funded work was accomplished on this project.

VII. PUBLICATIONS

A manuscript will be drafted and submitted to the Wildlife Society Bulletin. This draft, if not accepted for publication, will be submitted as an amendment to this Federal Aid final report.

VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

Because we were interested in specifically collaring elk, the study sites selected for this project – Etolin and Zarembo Islands – were extremely difficult and costly to get to. In retrospect, it would have been better to test and develop these snares on a higher-density deer population, and work on a road system where access would allow snares to be checked frequently. Frequent checking would allow snares that were brushed aside to be reset and continue working. We would also recommend working with tractable animals (game farm or zoo setting) to see how animals react to the snare around their neck, and what loop sizes and placement heights are most effective.

The existing collars will be deployed on an opportunistic basis by area biologists and research staff in an effort to learn more and refine our techniques. We remain concerned about the misuse of snares, and the potential capture of non-target animals. Catching a black bear (*Ursus americanus*), or a young of the year in one of these snares could lead to death by strangulation as the animal grows if the snares are not set properly (right location, season) and if appropriate safety mechanisms (e.g., weak link, long barbs) are not used.

Collaring efforts might be more effective if done during winter and early spring. Not only would antlers be off male animals, but tracks left in snow would allow snare sets to be located in areas of recent concentrated use.

IX. PROJECT COSTS FROM LAST SEGMENT PERIOD ONLY

For segment period 1 July 2001 – 30 June 2002 (W-27-5):

FEDERAL AID SHARE $ 53,800 STATE SHARE $ 18,000 = TOTAL $ 71,800

For segment period 1 July 2002 – 30 September 2002 (W-33-1):

FEDERAL AID SHARE $ 16,500 STATE SHARE $ 5,500 = TOTAL $ 22,000

X. LITERATURE CITED

ASHCROFT G AND D REESE. 1957. An improved device for capturing deer. California Fish and Game 43:193-199.

BEALE D-M 1966. A self-collaring device for pronghorn antelope. Journal of Wildlife Management 30:209-211.

BERINGER J, L-P HANSEN, W WILDING, J FISCHER, AND S-L SHERIFF. 1996. Factors affecting capture myopathy in white-tailed deer. Journal of Wildlife management 60:373-380.

CLARKE C-M-H AND R-J HENDERSON. 1978. Snare-marking chamois in New Zealand. Saugetierkunde 43:232-239. (Translated by Canadian Wildlife Service).

COCHRAN W-W AND R-D LORD. 1963. A radio-tracking system for wild animals. Journal of Wildlife Management. 27:9-24.

CONNER M-C, E-C SOUTIERE AND R-A LANCIA. 1987. Drop-netting deer: costs and incidence of capture myopathy. Wildlife Society Bulletin 15:434-438.

DENICOLA A-J AND R-K SWIHART 1997. Capture-induced stress in white-tailed deer. Wildlife Society Bulletin 1997 25:500-503.

KEITH L-B 1965. A live snare and tagging snare for rabbits. Journal of Wildlife Management 29:877-880.

ROMANOV A-N 1956. Automatic tagging of wild animals and prospects for its use. Zool. Zuhr 35(12):1902-1905.

SIGLIN R-J 1966. Marking deer with an automatic tagging device. Journal of Wildlife Management 30:631-633.

TAYLOR R-H. 1969. Self-attaching collars for marking red deer in New Zealand. Deer (1):404-407.

TESTER J-R, D-W WARNER W-W COCHRAN. 1964. A radio-tracking system for studying movements of deer. Journal of Wildlife Management 28:42-45.

VERME L-H 1962. An automatic tagging device for deer. Journal of Wildlife Management 26:387-392.

X. APPENDICES

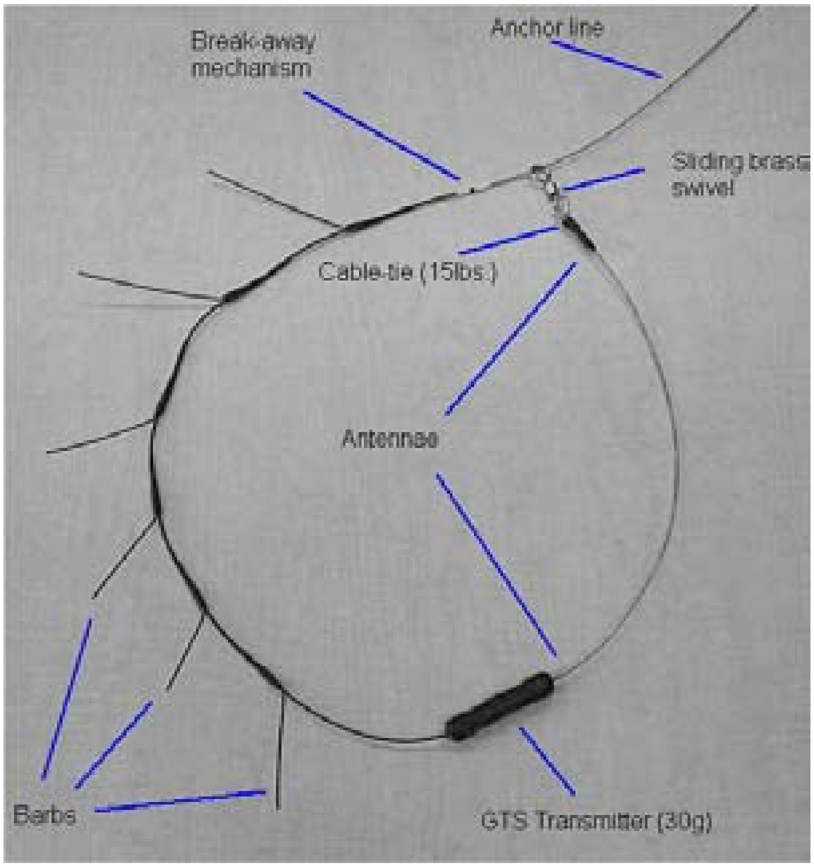

Figure 1. Final version of the non-expandable break-away snare radiocollar. The anchor line is typically secured to a tree with a fence staple. The break-away mechanism consists of adhesive heat-shrink PVC tubing bridging the gap between the 1/16” anchor line and the 1/16” snare cable. The tubing, which bonds to the cable, breaks under tension at the gap (breaking strength depends on type of heat-shrink used). Following are a series of barbs crimped to the line so that the swivel slides smoothly over each flexible barb but cannot back up (more than 10-15 cm, depending on length of last barb). To ease the transition over each crimp, putty or clay is applied posterior to each crimp, tapered to meet the cable, and all is covered with heat-shrink tubing. The transmitter (From Global Tracking Systems, Inc.) is held in place by two ½” copper pie caps with a 3/32” hole drilled in each to allow the snare cable (on one end) and antenna (on the other end) to exit. The snare cable is prevented from pulling back through the hole by a small aluminum stop crimped on the cable end. Both caps are pushed over the ends of the transmitter, and the entire assembly is held together with ¾ in diameter heavy duty heat shrink tubing (Thermafix ST, Merithian Product Corp.). A loop is formed in the distal end of the antenna so that a plastic cable tie can connect the antenna with the stainless steel swivel. The cable tie serves as an emergency breaking point should the collar become snagged while on the neck of the animal. The cable tie degrades in UV light, thus ensuring that the collar will eventually fall off the animal.

Table 1. Summary of self-attaching collar studies for large mammals. Of 88 snares set in this study, 9 ended up on animals at least temporarily. One collar remained on an animal (a deer) for > 1 year.

Species	Location	Collars Deployed	Collars Encountered	Collars Attached	Success rate	Duration (mos)	Source
White-tailed deer	Michigan	694		367	0.53	3	Verme 1962
White-tailed deer	N. Michigan	73		52	0.71	3	Verme 1962
Red deer	New Zealand	500		118	0.24	12	Taylor 1969
Chamois	New Zealand	380	268	220	0.58	48	Clarke and Henderson 1978
Elk	Etolin Island, AK	25	21	1[a]	0.04	1-4	This study
Elk	Zarembo Island, AK	31	20	4[b]	0.13	5	This study
Sitka Black-tailed deer	Prince of Wales Island, AK	10	6	1[c]	0.10	1.5	This study
Sitka Black-tailed deer	Douglas Island, AK	4	1	0	0.00	3	This study
Wolves	Prince of Wales Island, AK	18	11	3[d]	0.17	2	This study

[a] Collared animals include 1 unknown elk (probable) based on activity sensor. After 2 months, no signals from 3 missing transmitters (likely malfunction).
[b] Collared animals include 1 adult male elk (double collared), 1 elk (sex unknown), 1 wolf (probable)
[c] Black bear (probable). On for 7 days
[d] 2 on wolves temporarily, 1 on a deer (still on 1 year later)

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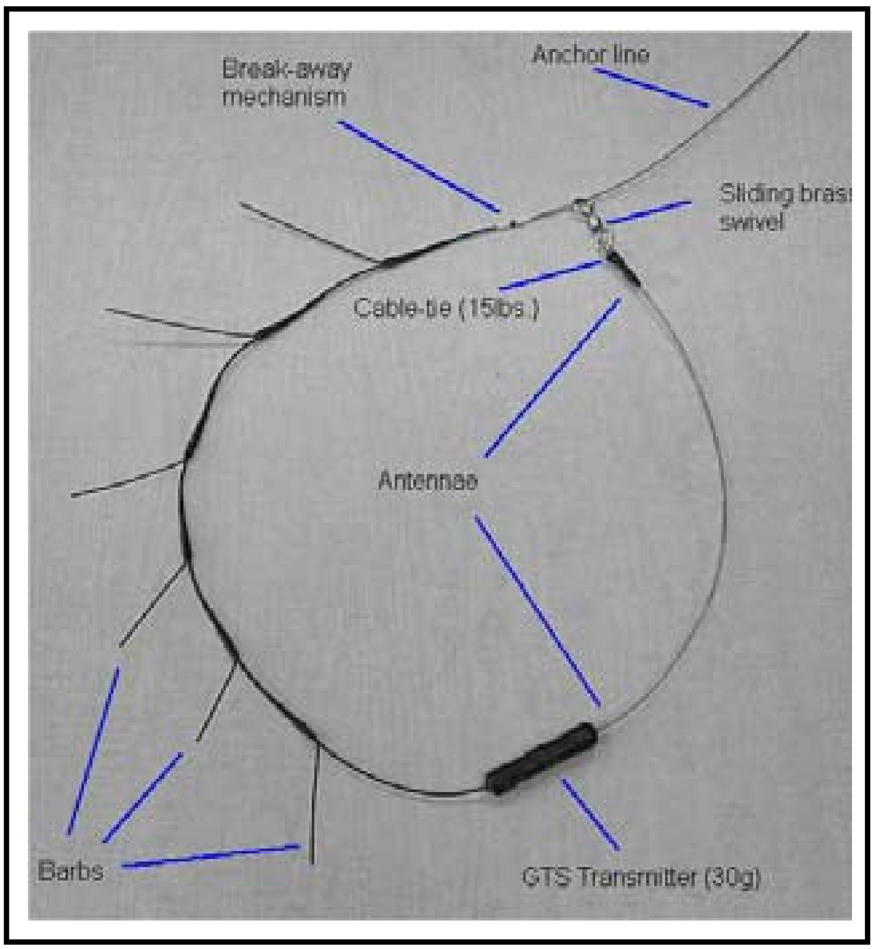
Division of Wildlife Conservation

APPROVAL DATE: __________________

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.



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