

# Translocations, transmitter effects, and veterinary care of otters (Mustelidae) during reintroduction

An Annotated Bibliography



August 1, 2007

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## Abstract

This bibliography synthesizes selected literature (e.g., abstracts, reports, peer-reviewed journal articles) relevant to the capture, veterinary care, and translocation success of river otters and other meso-bodied vertebrates. Coverage of this bibliography encompasses two broad subject areas: 1) a primary emphasis on veterinary aspects related to the specific care of otters and similar mustelids, and 2) and a secondary emphasis on contrasts in veterinary care with other animals of similar size, lifestyle, or taxonomy. Most citations are accompanied by an abstract or short annotation that summarizes the major findings or interpretations. Those portions of the annotation which contain the most striking findings for river otter reintroduction are indicated with bold-faced, blue font.

## Literature available

Ågren, E.O., L. Nordenberg, and T. Mörner. 2000. Surgical implantation of radiotelemetry transmitters in European badgers (*Meles meles*). *Journal of Zoo and Wildlife Medicine* 31: 52–55. -- The suitabilities of two subcutaneous and two intra-abdominal surgical approaches were evaluated for implantation of telemetry transmitters in the European badger (*Meles meles*). Two transmitters, one for heart rate and the other for body temperature, were needed in each badger. Five wild badgers were trapped, housed in an outdoor pen, anesthetized, and surgically implanted with one or two transmitters per procedure. A total of 16 transmitters were implanted, 10 subcutaneously and six intra-abdominally, and **each badger had up to three procedures performed**. Six subcutaneous transmitters were placed over the chest wall and four on the dorsal aspect of the neck. Three intra-abdominal transmitters were placed free in the abdomen and three were fixed to the abdominal wall. **Eight of the subcutaneous transmitters were later damaged or dislodged, probably by mechanical friction, injuries from fighting, or wound licking**. The intra-abdominal implantation procedures were easier and faster to perform compared with subcutaneous procedures. Two of the free intra-abdominal transmitters became thinly encapsulated, with some omental adhesions. The fixed intra-abdominal approach for transmitter implantation is preferable in badgers.

Colorado Division of Wildlife. 2003. **State of Colorado River Otter Recovery Plan, 6060 Broadway, Denver, Colorado 80216. 51 pp.** -- River otters often do not transplant easily and stress-related deaths may occur prior to transport, during transit, and soon after release. **Of 40 river otters captured in Oregon, only 27 (15 males, 12 females) survived to release in the Dolores River**. Within the first 2 weeks post-release, 6 river otters died in the canyon, 2 climbed out of canyon and died, and another became trapped on a cliff and would have died had he not been recaptured. Within 6 months, 2 otters had moved into the San Miguel and Colorado rivers where they established ranges. They had moved 125 miles and 190 miles from the release site. Thus the new population had to develop from an effective start of 17 river otters.

- Conway C.J., and V. Garcia. 2005. Research notes: effects of radiotransmitters on natal recruitment of burrowing owls. *Journal of Wildlife Management* 69: 404–408. -- Agencies responsible for managing rare or declining species should request that researchers incorporate evaluation of potential effects of their research methods into their study design. **Putting radiocollars on juvenile burrowing owls does not appear to be a research method that adversely affects first-year survival.** Future researchers and managers should use slightly tighter-fitting collars than those we used (2.8 cm diameter).
- Eagle, T.C., J. Choromanski-Norris, and V.B. Kuechle. 1984. Implanting radio transmitters in mink and Franklin's ground squirrels. *Wildlife Society Bulletin* 12(2): 180–184. -- Intraperitoneal implantation of radio transmitters was prompted by unsatisfactory results from collar- and harness mounted transmitters that caused severe neck irritation to the study animals.
- Erickson, D.W. and C.R. McCullough. 1987. Fates of translocated river otters in Missouri. *Wildlife Society Bulletin* 15(4): 511–517. -- Otters that strayed from relocation site had a lower chance of survival and it took at least two years for reproduction to occur in many of the animals [abstracting incomplete for this citation due to limited access].
- Fernandez-Moran, J., E. Perez, M. Sanmartin, D. Saavedra, and X Manteca-Vilanova. 2001. Reversible immobilization of Eurasian otters with a combination of ketamine and medetomidine. *Journal of Wildlife Diseases* 37(3): 561–565. -- The efficacy and safety of the combination of medetomidine and ketamine was examined in order to **establish an adequate chemical immobilization protocol in the Eurasian otter (*Lutra lutra*) for use during translocation projects in Spain.** Thirty-eight Eurasian otters ranging in body mass from 3 to 8.7 kg (mean 5.3 kg) were successfully anesthetized on 82 occasions. The dosage of ketamine was 5.1+/-0.8 (3.4-6.6) mg/kg (mean +/- SD; range) combined with medetomidine at a dosage of 51+/-8 Rg/kg (34-66 microg/kg). In most cases anaesthetic effect occurred within 3 min and the mean induction time was 5.5+/-3.2 min. The mean pulse rate was 95 beats/min. The mean respiratory rate was 32 respirations/min while the relative oxyhemoglobin saturation was 93%. **According to these results, this anesthetic protocol is considered safe and can be recommended in wild caught Eurasian otters for immobilization during translocation projects. It is safe, rapid and can be reversed when needed with atipamezole. However caution is required as heart depression resulting in bradycardia may occur.**
- Fernández-Morán, J., D. Saavedra, and X. Manteca-Vilanova. 2002. Reintroduction of the Eurasian otter (*Lutra lutra*) in northeastern Spain: trapping, handling, and medical management. *Journal of Zoo and Wildlife Medicine* 33: 222–227. -- In 1993 a reintroduction project for the Eurasian otter (*Lutra lutra*) was initiated in northeastern Spain (Girona, Catalonia) to restore extirpated populations. Between 1996 and 2000, 43 otters were captured from southwestern and northern Spain and from Portugal with modified foot-hold traps and transported to Barcelona Zoo. Lesions produced by capture were classified into four categories of increasing severity. Thirty four (79%) animals had category I, three (7%) had category II, five (12%) had category III, and only one (2%) had category IV injuries. **During captivity five (11%) animals died, including one from a precapture problem.** Radiotransmitter devices were implanted i.p. into 36 otters to monitor postrelease movement and survival. **At least**

**three radio-implanted otters have bred successfully in Girona province, Catalonia, after release in that area.**

Garshelis, D.L. and D.B. Siniff. 1983. Evaluation of radio-transmitter attachments for sea otters. *Wildlife Society Bulletin* 11: 378–383. – These early attempts to radiotag sea otters with collars or ankle bracelets were not successful.

Gervais, J.A., D.H. Catlin, N.D. Chelgren, and D.K. Rosenberg. 2006.

**Radiotransmitter mount type affects burrowing owl survival.** *Journal of Wildlife Management* 70: 872–876. -- Radiocollars appear to have effects on survival of burrowing owls in at least some years, but harnesses should be avoided because their effects can be severe. Training in fitting harnesses will be necessary for minimizing harness effects, but it is unlikely that this would be sufficient to eliminate the substantial negative impacts on the owls.

Guynn, D.C., Jr., J.R. Davis, and A.F. Von Recum. 1987. Pathological potential of intraperitoneal transmitter implants in beavers. *Journal of Wildlife Management* 51: 605–606. -- Three of 10 beavers implanted developed adhesions between the transmitting capsule and peritoneal tissues. One beaver died from intestinal obstruction as a result. **The other 9 beavers were necropsied and had no indications of harmful pathology.** Authors suggest encasing the implant in a layer of omentum during surgery to avoid complications caused by adhesion.

Hartup, B.K., G.V. Kollias, M.C. Jacobsen, B.A. Valentine, and K.R. Kimber. 1999.

**Exertional myopathy in translocated river otters from New York.** *Journal of Wildlife Diseases* 35(3): 542–547. -- **Lesions consistent with exertional myopathy (EM) were documented postmortem in four North American river otters (*Lutra canadensis*) during translocation for a population restoration project.** Clinical signs in these otters included depression, anorexia and shock. Gross lesions in one otter included locally extensive linear, pale areas within the subscapularis, rectus abdominis, quadriceps, and dorsal laryngeal muscles. Microscopic lesions were characterized by acute to subacute myofiber necrosis of varying severity, and occurred in a variety of skeletal muscles as well as cardiac muscle in one otter. Based on these observations, we conducted a retrospective review of records of otters which experienced similar capture, transfer, and holding protocols between 1995 and 1997, but with a successful outcome (n = 69). Significant elevations in serum aspartate aminotransferase (AST) and creatine kinase (CK) were observed in 19 (28%) of the otters, but may have been higher due to delayed sample collection from some otters. However, none of the otters with elevated enzymes exhibited clinical signs suggestive of EM. **These findings indicate that river otters may develop EM when translocated, but many cases may be mild or clinically inapparent.**

Hatfield, B.B., and G.B. Rathbun. 1996. Evaluation of a flipper-mounted transmitter on sea otters. *Wildlife Society Bulletin* 24(3): 551–554. --

Hernandez-Divers, S.M., G.V. Kollias, N. Abou-Madi, and B.K. Hartup. 2001.

**Surgical technique for intra-abdominal radiotransmitter replacement in North American river otters (*Lontra canadensis*).** *Journal of Zoo and Wildlife Medicine* 32: 202–205. -- Twenty-two free-ranging North American river otters (*Lontra canadensis*) from northern and eastern New York were captured and surgically implanted with radiotransmitters as part of a relocation project. The surgical technique involved an incision in the paralumbar fossa and transection through the abdominal musculature to introduce a radiotransmitter into the abdominal cavity. **Two complications were encountered. Excessive hemorrhage occurred during one procedure. The otter**

was treated for blood loss with fluids, and it recovered uneventfully. Surgical incision infection occurred in a second animal. The otter was treated with metronidazole and enrofloxacin, and the wound was cleaned daily with chlorhexidine. **The otter recovered uneventfully.** Otters were released in western New York state. Postrelease monitoring via radiotelemetry revealed that the otters became established in their new ranges. **The intra-abdominal implants did not affect their survival or reproductive potential.**

Huppa, J.W., J.M. Pearce, D.M. Mulcahya, and D.A. Millerb. 2006. Effects of abdominally implanted radiotransmitters with percutaneous antennas on migration, reproduction, and survival of Canada geese. *Journal of Wildlife Management* 70: 812–822. -- Abdominally implanted radiotransmitters with percutaneous antennas are increasingly used to monitor movements, survival, and reproduction of waterbirds. However, there has been relatively little assessment of the effects of such radios on avian demographic parameters or migration. We implanted either a 26- or 35-g abdominal transmitter with percutaneous antenna in 198 adult female lesser Canada geese (*Branta canadensis parvipes*) in Anchorage, Alaska during 2000 and 2001. We compared migration chronology, reproductive effort, and survival of radiomarked females to 118 control females marked with leg bands. Arrival dates following spring migration were similar among females in different treatments in 2001. However, in 2002, wind direction during late migration was less favorable, and arrival of females with 35-g radiotransmitters lagged 1–2 days behind that of control females. Nest initiation dates, clutch size, and mean egg volume were similar for 152 nests of females that lacked radios and 62 nests of radiomarked females. Estimated nesting propensity for females with operable radiotransmitters was 61% and 72% in 2001 and 2002, respectively. **Apparent annual survival ( $f = 0.82$ , 95% confidence interval: 0.76 to 0.87) was similar among treatments in the first year after geese were marked. In the second and third years after marking, model-averaged estimates for survival of females with large radiotransmitters were 10% lower than estimates for control females.** However, the effect of large radios on long-term survival was equivocal because of uncertainty surrounding treatment estimates. **We conclude that abdominally implanted radiotransmitters with percutaneous antennas had small effects on migration chronology but no apparent effects on fecundity.** Abdominal transmitters can provide unbiased estimates of anserine survival in the first year after deployment. Because of the potentially greater effects of larger transmitters on migration and long-term survival, we recommend that biologists minimize the size of implanted transmitters and deploy radios with caution if long-term survival of marked birds is a concern.

Kimber, K., and G.V. Kollias, II. 2000. Serologic survey of selected viral agents in recently captured wild North American river otters (*Lontra canadensis*). *Journal of Zoo and Wildlife Medicine* 31: 168–175. -- Blood samples were collected from 64 wild North American river otters (*Lontra [Lutra] canadensis*) from northern and eastern New York State and **analyzed for serologic evidence of exposure to selected viral agents during a 1995–1996 translocation program. No clinical signs of disease nor lesions suggestive of prior viral exposure were seen.** Titers were detected for antibodies against canine distemper virus, canine herpesvirus-1, and canine parvovirus-2 but not for antibodies against canine adenovirus-1, canine coronavirus, canine parainfluenza virus, rabies virus, feline herpesvirus-1, feline calicivirus, or feline

coronavirus. This is the first report of titers for antibodies against canine herpesvirus-1 in North American river otters, and it suggests a low prevalence of antibody titers against most canine viruses in otter populations in northern and eastern New York.

**Confounding variables in this study could include exposure to domestic dogs associated with the project, prolonged time spent in captivity, and concurrent bacterial or parasitic infection. Stress-associated humoral immune suppression could have altered serologic profiles, especially in otters exposed to dogs after trapping but before venipuncture.**

**Kimber, K., and G.V. Kollias, II. 2000. Infectious and parasitic diseases and contaminant-related problems of North America river otters (*Lontra canadensis*): a review. *Journal of Zoo and Wildlife Medicine* 31: 452–472.** -- The aquatic North American river otter (*Lontra canadensis*), a charismatic nonendangered mustelid, presently occupies a greatly reduced range. The species is common in zoos and has economic value as a furbearer. At least 17 states and one Canadian province have undertaken recent reintroduction programs. Nevertheless, little has been published on nonparasitic diseases of river otters, and little is known of the clinical significance of most of their parasitic infections. Records of environmental contaminant-related diseases and traumatic injuries in free-ranging North American river otters are also rare. **This paper reviews present knowledge of North American river otter diseases, especially those with the greatest potential for impacting reintroduction programs.**

**Kimber, K., and G.V. Kollias, II. 2005. Evaluation of injury severity and hematologic and plasma biochemistry values for recently captured North American river otters (*Lontra canadensis*). *Journal of Zoo and Wildlife Medicine* 36: 371–384.** -- As part of a reintroduction program, blood samples from free-ranging, recently captured Nearctic river otters (*Lontra canadensis*) in eastern New York state were collected and analyzed to determine baseline hematology and plasma biochemistry values for the source population, and to determine whether these values were significant predictors of trap-injury status. Based on physical exam, each otter was classified as uninjured, moderately injured, or severely injured. Clinical pathology parameters were compared across sex, age class, and injury classification. The increase in likelihood of a change in each parameter in injured versus uninjured otters was determined using logistic regression. **Baseline hematology and plasma biochemistry values did not differ significantly from published values for captive otters in zoos or other reintroduction programs.** Plasma aspartate aminotransferase levels increased as time from capture to venipuncture decreased. Some otters in this study showed clinical signs consistent with exertional myopathy, possibly altering our calculation of baseline values. Our results suggest that the hematology and plasma biochemistry values obtained in this recently captured population of otters are generally not good predictors of capture-related injury. This could be due to **disease processes that are not readily visible upon physical examination or because changes in these values may be associated with factors independent of capture-related injury.**

**Koen, H.J., J. Bowman, C.S. Findlay, and L. Zheng. 2006. Home range and population density of fishers in eastern Ontario. *Journal of Wildlife Management* 71: 1484–1493.** -- Did not report nor did this study appear to examine any trapping or radio-collaring effects on this mustelid.

**Mitcheltree, D.H., T.L. Serfass, W.M. Tzilkowski, R.L. Peper, M.T. Whary and R.P. Brooks. 1999. Physiological responses of fishers to immobilization with ketamine, ketamine-xylazine and telazol. *Wildlife Society Bulletin* 27: 582–591.**

- Mitcheltree, D.H., T.L. Serfass, R.L. Peper, et al. 1997. Captive care and clinical evaluation of fishers during the first year of a reintroduction project. In: Proulx, G., H.N. Bryant, and P.M. Woodard, (eds). *Martes: taxonomy, ecology, techniques and management*, Provincial Museum of Alberta, 317–328.
- Nolfo, L.E., and E.E. Hammond. 2006. A novel method for capturing and implanting radiotransmitters in nutria. *Wildlife Society Bulletin* 34: 104–110. -- As part of a multi-phase study aimed at examining the impact, habitat use, and movement patterns of the invasive rodent the nutria (*Myocastor coypus*), we developed a methodology to most effectively capture and implant these animals with radiotransmitters. Using a hand-held fishing net, we captured 20 adult nutrias from an airboat and implanted them with intraperitoneal radiotransmitters. We used the anesthetic tiletamine-zolazepam (Telazol®, Ft Dodge Animal Health, Ft. Dodge, Iowa) to immobilize the animals during surgery. We released all individuals back into a fresh water floating marsh habitat within 24 hours of implantation. **There was increased survivorship when we placed animals in a predator-free enclosure for a minimum of 3 days. We found that the combination of airboat capture, Telazol® anesthesia, and 24-hr post-surgery release was successful only if animals could be kept in a predator-free environment for at least 72 hours. Therefore, if holding facilities and sufficient temporal, monetary, and human resources are available, these methods may result in sufficient survivorship to allow for the monitoring of these and other medium-sized, semi-aquatic mammals.**
- O'Hearn, P.P., L.M. Romero, R. Carlson, and D.J. Delehanty. 2005. Effective subcutaneous radiotransmitter implantation into the furcular cavity of chukars. *Wildlife Society Bulletin* 33: 1033–1046. -- The wide use of radiotelemetry in avian field studies justifies the continued search for improved methods of attaching transmitters. **Subcutaneous implantation** of radiotransmitters into the furcular cavity of birds **has been proposed to ameliorate many deleterious effects of radiotransmitters** (J. Berdeen, South Carolina Cooperative Research Center, personal communication). Using wild adult chukars (*Alectoris chukar*) brought into captivity, we implanted radiotransmitters subcutaneously into their furcular cavity and compared a suite of behavioral, endocrinological, and physiological measures in implanted chukars with controls. **Implanted chukars did not differ from controls in maintenance, agonistic, or reproductive behaviors during 11 weeks of observation. Implanted chukars also did not differ from control chukars in an array of blood values designed to test for infection or implant rejection and did not experience chronic stress based on circulating corticosterone levels. Necropsy indicated complete healing of insertion sites with no signs of infection, foreign body reaction, or rejection. Implanted chukars did not differ from controls in mass, body fat, fecundity, or reproductive condition. We conclude that subcutaneous implantation of radiotransmitters into the furcular cavity was well tolerated by chukars and may prevent deleterious effects associated with other methods of transmitter placement.**
- Raesly, E.J. 2001. Progress and status of river otter reintroduction projects in the United States. *Wildlife Society Bulletin* 29: 856–862. -- The river otter (*Lontra canadensis*) is an important North American furbearer species that was eliminated from most of its range by the early 1900s. Many state agencies have undertaken restoration efforts, although no comprehensive study on the extent or type of management exists. I conducted telephone interviews with wildlife agency biologists in the 49 continental

states (USA) to update status and management of river otters, with emphasis on reviewing the use of reintroduction as a management tool to restore extirpated otter populations. **As of 1998, river otters occupied at least portions of their historic range in every state except New Mexico. Between 1976 and 1998, 21 states and 1 national park implemented reintroduction projects, releasing 4,018 river otters. States conducting reintroduction projects obtained otters from a variety of sources, but 14 (64%) used at least some otters obtained from coastal Louisiana. All states implemented post-release evaluations, including radiotelemetry studies by 15 projects. Based on various forms of direct and circumstantial evidence, most biologists stated that reintroductions were successful in restoring extirpated otter populations.**

- Ralls, K., D.B. Siniff, T.D. Williams, and V.B. Kuechle. 1989. An intraperitoneal radio transmitter for sea otters. *Marine Mammal Science* 5(4): 376–381. -- A small intraperitoneal radio transmitter was developed and used successfully in California sea otters. The transmitter weighs about 120 g and has an internal antenna. Thirty-five implanted transmitters were located for an average of 526 d. **The carcasses of five animals that died were recovered; there were no complications associated with the transmitters in these individuals. Reproductive performance of the adult females with implanted transmitters appeared normal.** The main advantages of this transmitter are its reliability and long life. It has enabled the collection of significant new information on California sea otters.
- Reid, D.G., W.E. Melquist, J.D. Woolington, and J.M. Noll. 1986. Reproductive effects of intra-peritoneal transmitter implants in river otters. *Journal of Wildlife Management* 50(1) 92–94. -- Data on 7 instrumented adult female river otters (*Lutra canadensis*) from 3 study areas in western North America were used to evaluate the effects on intra-peritoneal radio transmitter implants on reproductive performance. **Based on our observations, all stages of the breeding cycle can proceed successfully with a radio package implanted in the abdominal cavity.**
- Serfass, T.L., R.L. Peper, et al. 1993. River otter (*Lutra canadensis*) reintroduction in Pennsylvania: prerelease care and clinical evaluation. *Journal of Zoo and Wildlife Medicine* 24: 28–47.
- Serfass, T.L., M.T. Whary, R.L. Peper, et al. 1995. Rabies virus infection in a free-ranging river otter: implications for a translocation project. *Journal of Zoo and Wildlife Medicine* 26: 311–314.
- Serfass, T.L., R.P. Brooks, T.J. Swimley, L.M. Rymon, and A.H. Hayden. 1996. Considerations for capturing, handling, and translocating river otters. *Wildlife Society Bulletin* 24: 25–31.
- Siniff, D.B., and K. Ralls. 1991. Reproduction, survival and tag loss in California sea otters. *Marine Mammal Science* 7(3): 211–299. -- **We observed 40 California sea otters, *Enhydra lutris*, that were instrumented with implanted radio transmitters and flipper-tagged,** and obtained additional data on the reproduction of tagged female otters from the California Department of Fish and Game. The proportion of instrumented females accompanied by a pup peaked in the spring, with a secondary peak in the fall. Two methods of estimating the annual reproductive rate gave comparable values of 0.90 and 0.94. The average inter-birth interval was 389 d. Two methods of estimating pup survival to weaning gave values of 0.46 and 0.58. Pups either remained with a female less than 80 or more than 120 d. Early mortality of dependent pups appears to be more frequent in California than in Prince William Sound, Alaska. Two



methods of estimation indicated that adult females had the highest survival rates and adult males the lowest. Juvenile females had lower survival rates than adult females but juvenile males had higher survival rates than adult males. The survival rate of juvenile females was lower than that of juvenile males. The estimated annual loss rate for flipper-tags, based on the instrumented individuals, was 0.26. More individuals lost two tags than would be expected by chance. **It is unlikely that accurate estimates of sea otter survival rates can be derived from observations of tagged individuals.**

**Spelman L.H., W.J. Jochem, P.W. Sumner, D.P. Redmond, and M.K. Stoskopf. 1997. Postanesthetic monitoring of core body temperature using telemetry in North American river otters (*Lutra canadensis*). *Journal of Zoo and Wildlife Medicine* 28(4): 413–417.** -- Remote thermal telemetry was performed on North American river otters (*Lutra canadensis*) during the 1995 North Carolina Wildlife Resources Commission Otter Restoration Project. Otters were anesthetized with either ketamine-midazolam (n = 11) or tiletamine-zolazepam (n = 9) combinations. **Based upon initial rectal temperatures, mild to moderate hyperthermia (39.4–40.5 degrees C) developed in five otters given ketamine-midazolam and three otters given tiletamine-zolazepam.** Following anesthetic induction, each otter received an ingestible temperature transmitter. Dependent upon gastrointestinal transit time and transmitter battery life, core body temperature was monitored for up to 13.75 hr postanesthesia. Thermal telemetry revealed a gradual decline in core temperature in all otters after anesthetic recovery (30–60 min). **Median core temperature stabilized subsequently within 0.3 degrees C of resting temperature (38.4 degrees C) 1.75 hr after initial injection in otters given tiletamine-zolazepam and 2.75 hr in otters given ketamine-midazolam. Minor fluctuations in body temperature (less than 1 degree C) occurred in most otters from 6 to 13.75 hr and were attributed to variations in physical activity.**

**Tocidlowski, M.E., L.H. Spelman, P.W. Sumner, and M.K. Stoskopf. 2000. Hematology and serum biochemistry parameters of North American river otters (*Lutra canadensis*). *Journal of Zoo and Wildlife Medicine* 31: 484–490.** -- Blood samples were obtained from 155 North American river otters (*Lutra canadensis*; 94 adult males, 38 adult females, 10 juvenile males, and 13 juvenile females) to establish baseline hematology and from 50 adult river otters (40 males and 10 females) for baseline serum biochemistry parameters for the species. The otters were livetrapped from eastern North Carolina (USA) during a 4-yr period. Data for 14 routine hematologic parameters and 22 serum chemistry assays showed significant differences in total leukocyte count and absolute neutrophil and monocyte numbers for adults versus juveniles, red blood cell counts and hemoglobin between adult and juvenile males, and calcium and alkaline phosphatase values for adult males between years of the study and an **increase in leukocyte counts and absolute neutrophils with increased degree of trap injury sustained.**

**Van Vuren, D. 1989. Effects of intraperitoneal transmitter implants on yellow-bellied marmots. *Journal of Wildlife Management* 53: 320–323.** -- Found similar pregnancy rates and mean litter sizes between female yellow-bellied marmots surgically implanted with transmitters and females not implanted.