Reducing the impacts of leg hold trapping on critically endangered foxes by modified traps and conditioned trap aversion on San Nicolas Island, California, USA

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SUMMARY

Padded leg-hold live traps were used as the primary removal technique in the successful eradication of feral cats *Felis silvestris catus* from San Nicolas Island, California, USA. Risk of injury to endemic San Nicolas Island foxes *Urocyon littoralis dickeyi*, a similarly sized and more abundant non-target species, was mitigated by using a smaller trap size, modifying the trap and trap set to reduce injuries, and utilising a trap monitoring system to reduce time animals spent in traps. Impacts to foxes during the eradication campaign were further reduced by having a mobile veterinary hospital on island to treat injured foxes. Compared to other reported fox trapping efforts, serious injuries were reduced 2-7 times. Trapping efforts exceeded animal welfare standards, with 95% of fox captures resulting in minor or no injuries. Older foxes were more likely to receive serious injury. Fox captures were also reduced through aversive conditioning, with initial capture events providing a negative stimulus to prevent recaptures. Fox capture rates decreased up to six times during seven months of trapping, increasing trap availability for cats, and improving the efficacy of the cat eradication program. No aspect of the first capture event was significantly linked to the chance of recapture.

BACKGROUND

Eradicating feral cats from islands is an important action for protecting threatened island species; at least 87 successful cat eradications have been conducted worldwide (Campbell *et al.* 2011).

Managing non-target impacts is a critical component of eradication campaigns. Non-target species can reduce the effectiveness of eradication methods by reducing target species' access to bait, traps or other removal tools; and can increase the cost and complexity of eradication efforts because more efficient methods (e.g. toxic baiting) may present an unacceptable risk to non-target species (Campbell *et al.* 2011). Options to manage non-target impacts include measures to reduce injury and increase selectivity of traps (Table 1), aversive conditioning to to minimize recapture (Phillips & Winchell 2011), and mitigation such as capturing and holding non-target species (Howald *et al.* 2010). However, whilst minimizing negative impacts on native non-target species is a common goal in eradication projects, some non-target mortality may be considered acceptable when there are significant long-term benefits to native and threatened species populations (Bester *et al.* 2002).

Live traps allow non-target species to be released upon capture and target species to be dispatched or removed alive. Box traps are inefficient at capturing all cats in a population because some individuals may be hesitant to enter the trap or not attracted to baits or lures, and are therefore inappropriate as the sole trapping technique in cat eradication campaigns (Domm & Messersmith 1990, Twyford *et al.* 2000, Short *et al.* 2002). Leg-hold traps are an efficient means of capturing feral cats and have been employed in 68% of all successful feral cat eradication campaigns (Campbell *et al.* 2011). Leg-hold traps should be utilized in ways that minimize the potential for injury to captured target or non-target animals (AFWA 2006, AVMA 2008). Padded leg-hold traps cause less injury and trauma and are equally effective when compared to unpadded leg-hold traps (Kreeger *et al.* 1990, Fleming *et al.* 1998).

The island fox (*Urocyon littoralis*) is listed as Critically Endangered on the IUCN Red List, and four of the six subspecies are listed as Endangered under the US Endangered Species Act (ESA, USFWS 2004). The San Nicolas Island (SNI) subspecies (*U. l. dickeyi)* is not listed as endangered under the ESA, but is listed as threatened by the California Department of Fish Game and the population is monitored closely due to declines reported for the other subspecies. SNI foxes overlap in habitat use, and display similar behavior to feral cats, leading to challenges when attempting to exclude them from traps set for cats. Foxes on SNI weigh an average of 1.7 kg compared to 2.5kg for feral cats, have paw and body size similar to a juvenile feral cat, overlap in diet with feral cats, and regularly used the same travel routes as cats. Island foxes further complicate the situation by occrring at high densities on the island (up to 16/km^2) and being behaviorally “trap-happy” toward box traps (capture rates 33.7-52.1%, Garcelon & Hudgens 2011); characteristics that further reduce opportunities to capture cats if using box traps.

We report the reduction of impacts on an abundant non-target species, the island fox, during a successful cat eradication campaign on SNI. We report on two goals 1) reduced rates of injury in foxes caught in padded leg-hold traps, and 2) aversive conditioning through capture acting as a negative stimulus causing foxes to avoid trap sets in the future.

ACTION

Study Site: SNI is located approximately 105 km off the coast of Southern California, USA, and is owned and operated by the US Navy, with infrastructure and facilities to support 100-200

Table 1. Modifications and techniques used to reduce injury or increase selectivity of leg-hold traps.

Measures to reduce injury	**Source**
Padded jaws	Fleming *et al.* 1998, Seddon *et al.* 1999, AVMA 2008
Laminated off-set jaws	Houben *et al.* 1993
Trap monitoring system (to increase trapper response time and decrease animal time spent in trap)	Will *et al*. 2010
Trap tranquilizer device to sedate captured animals	Sahr & Knowlton 2000
Centrally mounted swivel to base plate, shortened chain length with shock-absorbing springs and additional swivels	Fleming *et al.* 1998, Hanson *et al.* 2010
Measures to increase selectivity	
Pan tension calibrated for target species	Mowat *et al.* 1994, Phillips & Gruver 1996
Traps only open when target is active (diurnal / nocturnal)	Shivik & Gruver 2002, Ratcliffe *et al.* 2010
Traps open seasonally to avoid impacting the offspring of non-target species	Hanson *et al.* 2010
Use of species specific lures	Moseby *et al.* 2004, Algar *et al.* 2010
Traps placed for individual animals	Bloomer & Bester 1992
Elevate traps (stilts, board, bucket of sand)	Morriss *et al.* 2000, Short *et al.* 2002, Algar & Johnston 2010
Width and shape of trap jaws when set	Fleming *et al.* 1998
Placement of obstacles around trap	Pruss *et al.* 2002, Wood *et al.* 2002
Placement within the environment	Fleming *et al.* 1998

personnel. The 5,896 ha island supports a number of species endemic to either the Channel Islands or the island itself, including at least 20 plant species, 25 invertebrates, one reptile, two birds and two terrestrial mammals (US Navy 2003). On SNI, feral cats preyed upon the federally listed island night lizard (*Xantusia riversiana riversiana*), the endemic island deer mouse (*Peromyscus maniculatus exterus*), seabirds, and other native wildlife. Feral cats competed for food and possibly other resources (e.g. dens) with the endemic SNI fox. Feral cats on SNI had tested positive for the feline disease toxoplasmosis (*Toxoplasmosis gondii*) which posed a threat to island fox, marine mammals and humans (Clifford *et al.* 2006). Cats were determined to pose a significant threat to the island's biodiversity, leading to the decision for them to be removed (USFWS 2009).

Pre-eradication Trials: In 2006, a 20-day trapping trial tested the techniques intended for use in the full eradication program. The purpose of this trial was to show a) that SNI fox could be captured in padded leg-hold traps and released with a low frequency of injury, b) SNI fox would begin to avoid trap sets leading to reduced capture rates over time, and c) that methods used would capture feral cats.

All leg-hold trap sets were walk-through sets based on Wood *et al.* (2002) with modifications to reduce injury rates to island fox, which have a less robust bone structure than feral cats. Victor soft-catch #1 size padded leg-hold traps were used in place of the larger #1.5 size traps typically used to target cats. Traps were anchored to the ground, rather than attached to vegetation or drags. The anchor was attached to the center of the trap's base-plate by wire cable and chain with a shock-absorbing coil-spring. A scent lure mixture of cat urine, feces, glycerin and sometimes catnip was used in place of bait. The scent acted as a lure to cats and it was hoped it would also facilitate olfactory recognition of trap sets by foxes. It was also hoped that the consistent positioning of rocks, stepping sticks and brush as part of the trap set provided a means for visual recognition by foxes of trap sets. The area around a trap set was cleared of any vegetation that could tangle in the anchor cable or trap and keep the trap from spinning freely. Similarly, only light, dry sticks that could break easily and not restrict trap movement were used in the trap set. All foxes captured were assigned an injury class in the field, derived from injury classes (I slight, II moderate, III severe, and IV very severe) modified from Van Ballenberghe (1984) with an additional class (V) for deaths (after Fleming et al. 1998).

Cat Eradication Campaign: Feral cats were eradicated from SNI, with trapping being the primary removal method used from June 2009 - January 2010 (limited hunting was also used; the last two animals were removed lethally by hunting) Padded leg-hold traps were used and injury classification conducted as described for the pre-eradication trial. Additional trap modifications were incorporated to further reduce the risk of injury. These included a shorter anchor cable and chain, lighter spring, and additional swivels to allow unrestricted rotation of the trapped animal (Hanson *et al*. 2010).

New traps were added gradually to allow personnel to keep up with the high capture rates. Complete coverage of the island with traps occurred in 69 days, with up to 236 active traps across the island at any given time. Trapping was not used during the March-June fox pupping season to further reduce potential impacts to the foxes. Traps were typically only checked during daylight hours due to safety concerns, and the number of active traps was reduced during rainy periods to allow trappers to respond to traps 24 hours a day.

A custom trap monitoring system using a radio repeater system and internet-based interface was developed and trap monitors were deployed with each trap set to allow for remote checking of the trap and rapid response to any captures (Will *et al.* 2010). This was especially critical during hot days (hyperthermia could occur within 20 minutes) and cold, rainy/foggy nights when foxes were susceptible to hypothermia.

Handheld field computers were used to record all trapping data during the eradication (Will *et al.* 2010). Trapped foxes were removed from traps, inspected for injuries, sexed, aged by dentition according to Collins (1993) and Woods (1958), and had passive integrated transponders inserted for individual identification if one had not been implanted previously. Foxes with no or minor injuries were released at the site of capture. Any animal with or suspected of having more serious injuries (trap related or not) were taken to an on-island mobile veterinary hospital for inspection and care. A small number of foxes appeared to have class III or IV injuries in the field, but examination at the veterinary hospital determined there was no serious injury (e.g. suspected broken bones or dislocation turned out to be arthritic joints); these injury assignments were later adjusted to reflect this.

The risk of death for foxes due to trapping could not be completely eliminated. Prior to project initiation, project partners established protocols to review trapping methods after any death or serious injury (class III-V) to a fox and determine whether to a) continue, b) modify the method to minimize future occurrence, c) abandon the method, or d) abandon the eradication effort entirely.

We investigated the differences in the rate of a) adjusted class III-V injuries, and b) recapture events based on age, sex, capture leg and duration in trap. Age was divided into four categories (age class 0-1, 2, 3, 4), sex and capture leg into two categories (front leg, hind leg), capture length into three categories (0-4, 4-8, >8 hours), and injury into two categories (injury class I-II, III-V). We also investigated whether the rate of recapture was related to injury class from the first capture.

CONSEQUENCES

Pre-eradication Trials: A total of 64 captures of 41 individual foxes occurred during the 2006 trial. The use of smaller traps with modifications was successful in minimizing the more serious (class III-V) injuries in the SNI fox with 4.5% of foxes receiving class III-IV injuries and no deaths occurring. Fox capture rates (calculated as captures per trap night) during the first seven days of the trial were 0.21, dropping to 0.02 during the last seven days, showing an 11-times reduction in capture rates. A total of 14 cats were removed during the trial, providing confidence that the measures to reduce non-target impacts would not compromise an eradication attempt.

Injury Reduction: A total of 1,011 captures of 459 individual foxes occurred during the eradication campaign. Rates of class III-V injuries were consistent with the 2006 trial, with 4.8% of fox captures resulting in class III-V injuries. Other fox trapping studies recorded 2-7 times more class III-V injuries than found in this project (Fleming *et al.* 1998, Seddon *et al.* 1999). Minor (class II) injuries were reduced in the eradication campaign compared to the 2006 trial from 25.4% to 4%. This reduction in minor injuries is likely due to the additional trap modifications made between the trial and eradication.

Animal welfare guidelines for live traps require that ≥70% of trapped animals must have minor or no injuries, i.e. injury class I or II (AFWA 2006). Both the pre-eradication trial and cat eradication campaign exceeded this threshold with 95% of trapping resulting in class I or II injuries only.

Trap modifications designed to reduce fox injury still allowed cats to be caught (51 in total). However, the use of small traps for cats was challenging, as cats are more likely to avoid narrow sets or jump over them. The use of small traps is therefore not recommended for other cat eradication programs unless non-target species of a similar size to the SNI foxes are present.

No significant difference in the rate of class III-V injuries was observed based on sex (X^2=3.573, df=1, P=0.059), capture leg (X^2=0.25, df=1, P=0.615), or capture length (X^2=1.95, df=2, P=0.377). Despite non-significant results for capture length and serious injury, we note two events where the trap monitoring system failed, in which foxes were held in the trap for >15 hours. These foxes sustained class IV injuries, possibly due to reduced circulation in the trapped limb, suggesting trap duration >15 hours increases the chance of injury.

Older foxes (age class 4) were significantly more likely to sustain a serious injury (X^2=8.56, df=3, P=.035) as a result of being captured. This increased rate of serious injury in older foxes was 7.8%; still within established animal welfare guidelines and lower than the overall rate of serious injury in comparable studies. Three foxes are known to have died as a result of the trapping efforts during the eradication; one died of hyperthermia and was found deceased in the trap <2.5 hours after being captured, and two died of hypothermia after being removed from traps (the first in transport to, and a second while receiving, veterinary care; Garcelon 2010).

In 2010, foxes were captured by IWS staff around SNI using box traps to inspect for post-release physical effects of leg-hold trapping. Of 70 foxes examined that had been previously captured in leg-hold traps, none showed evidence of injuries previously unnoticed or manifesting after release (Garcelon 2010). By contrast, Seddon *et al.* (1999) observed more serious injuries becoming apparent after release from #3 size padded leg-hold traps and subsequent cage trapping indicated that capture in leg-hold traps decreased survival rates.

All 51 trapped cats showed only minor (class I) injuries, a result consistent with other studies which found that trapped cats had fewer class III-V injuries than foxes, likely due to their heavier bone structure (Fleming *et al.* 1998). Cats trapped on SNI were taken into captivity and transferred to an enclosed outdoor facility on the mainland. These cats have not exhibited any effects from being captured in leg-hold traps after >2 years post-capture.

Conditioned Trap Aversion

Capture rates of SNI fox decreased through time during the eradication campaign. The average capture rate per night during the first week a trap was open was 0.19, dropping to 0.06 during the second week, and 0.03 during the twentieth week, showing a 3-times and 6-times reduction in captures respectively.

Initial capture events in padded leg-hold traps appear to provide enough negative stimuli to discourage subsequent recapture (aversive conditioning). Incidental observations of fox tracks showed trap avoidance by hopping over sets or going off established trails to go around them, consistent with these data. No significant difference in recapture rates was observed based on injury class (X^2=0.338, df=1, *P*=0.561), sex (X^2=0.259, df=1, *P*=0.611), age (X^2=3.044, df=3, *P*=0.3848), capture leg (X^2=0.013, df=1, *P*=0.906), or duration of time in a trap during the first capture event (X^2=4.487, df=2, *P*=0.106), suggesting these parameters had no influence on the strength of the induced aversion to trap sets.

Foxes appeared to associate the negative stimulus of capture with trap sets in general as well as the capture location. During the eradication campaign, more than 90% of recaptures occurred in a trap set in which the fox had not previously been captured. There were only 39 instances of a fox being captured at the same location twice, and one fox was captured in the same trap set three times. Foxes may have learnt to recognize trap sets after being captured 1-3 times (Table 2). Alternatively foxes may have learnt the specific trap locations within their home range, but we have no simultaneous home-range data with which to test this hypothesis.

CONCLUSIONS

Leg-hold trapping is a valuable eradication method, and in many cases risks to non-target species can be avoided, minimized or mitigated. During the SNI cat eradication project, customising traps and trap sets and incorporating a trap monitoring system to enable quick response to captures proved to be effective in reducing injury rates to non-target species. Furthermore, initial capture events of foxes acted as a negative stimulus to reduce subsequent recapture, and increased availability of traps to capture cats. An onsite veterinary hospital allowed us to treat any serious injuries, likely reducing non-target mortality rates. These results have application for other feral cat eradication or control campaigns where similar sized non-target species of conservation concern occur such as other California Channel Islands (San Clemente and Santa Catalina both have feral cats and island foxes), the Tres Marias island group in Mexico (two islands have cats and the Tres Marias raccoon *Procyon insularis*), and Cozumel Island in Mexico (four small carnivore species).

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REFERENCES

Algar D., Angus, G.J., Brazell, R.I., Gilbert, C. & Withnell, G.B. (2010) Eradication of feral cats on Faure Island, Western Australia. *Journal of the Royal Society of Western Australia*, **93**, 133-140.

Algar, D. & Johnston, M. (2010) Proposed management plan for cats and black rats on Christmas Island. Western Australian Department of Environment and Conservation, pp. 63.

Table 2. Frequency of capture of individual foxes in leg-hold traps on San Nicolas Island during the 2009/2010 cat eradication campaign. Approximately half of the island's fox population was only captured once or twice, even though traps were available for up to 188 nights.

Number of times captured	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Number of individuals	151	149	110	36	12	1	1	459 foxes

AVMA [American Veterinary Medical Association] (2008) Welfare implications of leghold trap use in conservation and research, pp.5.

AFWA [Association of Fish & Wildlife Agencies] (2006) Best management practices for trapping in the United States, pp.13.

Bester, M.N., Bloomer, J.P., van Aarde, R.J., Erasmus B.H., van Rensberg P.J.J., Skinner J.D., Howell P.G. & Naude T.W. (2002) A review of the successful eradication of feral cats from sub-Antarctic Marion Island, Southern Indian Ocean. *South African Journal of Wildlife Research*, **32**, 65-73.

Bloomer, J.P. & Bester, M.N. (1992) Control of feral cats on sub-Antarctic Marion Island, Indian Ocean. *Biological Conservation*, **60**, 211-219.

Campbell K.J., Harper G., Hanson C.C., Algar D., Keitt B.S. & Robinson S. (2011) Review of feral cat eradications on islands. 37-46 in: C. R. Veitch, M. N. Clout and D. R. Towns (eds) *Island invasives: Eradication and management*, IUCN, Gland, Switzerland.

Clifford D.L., Mazet J.A.K., Dubovi E.J., David K. Garcelon, Coonan T.J., Conrad P.A. & Munson L. (2006) Pathogen exposure in endangered island fox (*Urocyon littoralis*) populations: implications for conservation management. *Biological Conservation*, **131**, 230-243.

Collins, P.W. (1993) *Taxonomic and biogeographic relationships of the island fox (Urocyon littoralis) and gray fox (U. cinereoargenteus) from Western North America*. Proceedings of the Third California Island Symposium: Recent advances in research on the California Islands. Santa Barbara Museum of National History, Santa Barbara, CA, pp. 351-390.

Domm, S. & Messersmith, J. (1990) Feral cat eradication on a barrier reef island, Australia. *Atoll Research Bulletin*, **338**, 1-4.

Fleming, P.J.S., Allen, L.R., Berghout, M.J., Meek, P.D., Pavlov, P.M., Stevens, P., Strong, K., Thompson, J.A. & Thomson, P.C. (1998) The performance of wild-canid traps in Australia: efficiency, selectivity and trap-related injuries. *Wildlife Research*, **25**, 327-338.

Garcelon, D. (2010) Annual report on island fox care and monitoring provided in support of the San Nicolas Island seabird restoration program - 2009. Unpublished report.

Garcelon, D.K. & Hudgens, B.R. (2011) Island fox monitoring and demography on San Nicolas Island -2010. Final Report. Unpublished report.

Hanson C.C., Bonham, J.E., Campbell, K.J., Keitt, B.S., Little, A.E. & Smith, G. (2010) *The removal of feral cats from San Nicolas Island: Methodology*. Proceedings of the 24th Vertebrate Pest Conference. Sacramento, California, pp. 72-78.

Houben, J.M., Holland, M., Jack, S.W. & Boyle, C.R. (1993) *An evaluation of laminated offset jawed traps for reducing injuries to coyotes*. Proceedings of the Great Plains Wildlife Damage Control Workshop Proceedings. University of Nebraska - Lincoln, pp. 148-153.

Howald G.R., Donlan, C.J., Faulkner, K.R., Ortega, S., Gellerman, H., Croll, D.A. & Tershey, B.R. (2010) Eradication of black rats *Rattus rattus* from Anacapa Island. *Oryx*, **44**, 30-40.

Kreeger T.J., White, P.J., Seal, U.S. & Tester, J.R. (1990) Pathological responses of red foxes to foothold traps. *Journal of Wildlife Management*, **54**, 147-160.

Morriss, G.A., Warburton, B. & Ruscoe, W.A. (2000) Comparison of the capture efficiency of a kill-trap set for brushtail possums that excludes ground-birds, and ground set leg-hold traps. *New Zealand Journal of Zoology*, **27**, 201-206.

Moseby, K.E., Selfe, R. & Freeman, A. (2004) Attraction of auditory and olfactory lures to feral cats, red foxes, European rabbits and burrowing bettongs. *Ecological Management and Restoration*, **5**, 228-231.

Mowat G., Slough, B.G. & Rivard, R. (1994) A comparison of three live capturing devices for lynx: capture efficiency and injuries. *Wildlife Society Bulletin*, **22**, 644-650.

Phillips, R.B. & Winchell, C.S. (2011) Reducing nontarget recaptures of an endangered predator using conditioned aversion and reward removal. *Journal of Applied Ecology*, **48**, 1501-1507.

Phillips, R.L. & Gruver, K.S. (1996) Performance of the Paws-I-Trip pan tension device on 3 types of traps. *Wildlife Society Bulletin*, **24**, 119-122.

Pruss S.D., Cool, N.L., Hudson, R.J. & Gaboury, A.R. (2002) Evaluation of a modified neck snare to live-capture coyotes. *Wildlife Society Bulletin*, **30**, 508-516.

Ratcliffe, N., Bell, M., Pelembe, T., Boyle, D., White, R.B.R., Godley, B., Stevenson, J. & Sanders, S. (2010) The eradication of feral cats from Ascension Island and its subsequent recolonization by seabirds. *Oryx*, **44**, 20-29.

Sahr, D.P. & Knowlton, F.F. (2000) Evaluation of tranquilizer trap devices (TTDs) for foothold traps used to capture gray wolves. *Wildlife Society Bulletin*, **28**, 597-605.

Seddon, P.J., Van Heezik, Y. & Malone, R.F. (1999) Short- and medium-term evaluation of foothold trap injuries in two species of fox in Saudi Arabia. 67-78 in: G. Proulx (eds) *Mammal Trapping*, Alpha Wildlife Research and Managment Ltd., Alberta, Canada.

Shivik, J.A. & Gruver, K.S. (2002) Animal attendance at coyote trap sites in Texas. *Wildlife Society Bulletin*, **30**, 502-507.

Short J., Turner, B. & Risbey, D. (2002) Control of feral cats for nature conservation. III. Trapping. *Wildlife Research*, **29**, 475-487.

Twyford, K.L., Humphrey, P.G., Nunn, R.P. & Willoughby, L. (2000) Eradication of feral cats (*Felis catus*) from Gabo Island, south-east Victoria. *Ecological Management and Restoration*, **1**, 42-49.

USFWS [U.S. Fish & Wildlife Service] (2004) Listing the San Miguel Island fox, Sant Rosa Island fox, Santa Cruz Island fox, and Santa Catalina Island fox as endangered. *Federal Registers*, **69**, 10335-53.

USFWS [U.S. Fish & Wildlife Service] (2009) Final environmental assessment for the restoration of San Nicolas Island's seabirds and protection of other native fauna by eradicating feral cats. Report on behalf of the Montrose SettlementsTrustee Council and U.S. Navy, pp. 79.

US Navy (2003) Integrated natural resource management plan for San Nicolas Island.

Van Ballenberghe, V. (1984) Injuries to wolves sustained during live-capture. *The Journal of Wildlife Management*, **48**, 1425-1429.

Will D., Hanson C.C. & Campbell K.J. (2010) *A trap monitoring system to enhance efficiency of feral cat eradication and minimize adverse effects on non-target endemic species on San Nicolas Island*. Proceedings of the 24th Vertebrate Pest Conference. Sacramento, CA, pp. 79-85.

Wood, B., Tershy, B.R., Hermosillo, M.A., Donlan, C.J., Sanchez, J.A., Keitt, B.S., Croll, D.A., Howald, G.R. & Biavaschi, N. (2002) Removing cats from islands in northwest Mexico. In: *Turning the tide: the eradication of invasive species* (C. R. Veitch & M. N. Clout eds.) IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland, pp. 374-380.

Woods, J.E. (1958) Age structure and productivity of a gray fox population. *Journal of Mammology*, **39**, 74-86.