From the Field: Capturing beavers in box traps

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Box traps have been widely used in North American wildlife research studies for live capture of terrestrial animals such as coyotes (*Canis latrans*) (Kamler et al. 2002, Way et al. 2002), foxes (*Vulpes* spp.) (White et al. 1991, Kamler et al. 2002), lynx (*Lynx canadensis*) (Mowat et al. 1994, Kolbe et al. 2003), and raccoons (*Procyon lotor*) (Gehrt and Fritzell 1996), but little is known about the efficacy of box traps to capture aquatic species such as beavers (*Castor canadensis*). Beavers typically are live-captured with snares (McKinstry and Anderson 2002), suitcase-type traps like the Hancock (Hodgdon 1978) and Bailey (Buech 1983) designs, or, more recently, hand nets (Rosell and Hovde 2001). In some states, like Massachusetts, snares are illegal. Snares and Hancock and Bailey traps can be camouflaged, partially or fully submerged, and hidden from beavers. It is not known whether beavers will enter box traps, which are more difficult to conceal, on a consistent basis or whether capture would be biased to specific age or sex classes.

In a review on methods of live-trapping beavers, Rosell and Kvinlaug (1998) reported that a variety of box trap designs have been used in Russia, Germany, Norway, Finland, and Sweden, primarily for nuisance beaver control, but very little quantitative information was available on the capture efficiency and sex and age composition of beavers caught with these traps. There has been no report of the use of box traps to capture beavers in North America. In a recent review of trapping techniques for mammals, Powell and Proulx (2003) do not include beaver in their list of species that can be captured with box traps.

In 2001–2003, we modified and used commercially available box traps to capture beavers for a study on demography and movements of beavers across a suburban–rural gradient in 3 study areas in Massachusetts. Here we report on capture success of beavers in box traps, explain box trap designs and modifications, describe our field sets, and present costs of purchasing and modifying traps.

Study area

In 2001 we established 3 870-km^2 study areas in northeastern, central, and western Massachusetts to represent different degrees of human development, from heavy suburban in the northeast, to mixed rural and light suburban in central, to rural in the west. These areas also were where the state wildlife agency conducted annual beaver colony surveys (Massachusetts Division of Fisheries and Wildlife [MDFW], unpublished data). Major forest vegetation included transition hardwoods–white pine (*Pinus strobus*)–eastern hemlock (*Tsuga canadensis*), central hardwoods–eastern hemlock–white pine, and northern hardwoods–eastern hemlock–white pine (Westveld et al. 1956). Elevation increased from 36–207 to 225–438 to 207–650 m from east to west. Percent of residential development and human and road densities east to west were as follows: 336, 64, and 17 people/km^2 (Massachusetts Municipal Association 1995); 0.83, 0.48, and 0.28 km of roads/km^2 (MassGIS, Executive Office of Environmental Affairs, Boston, Mass.; www.ma.us/mgis), and 38%, 15%, and 8% residential development (MacConnell et al. 1991), respectively. Surveys for beavers conducted in

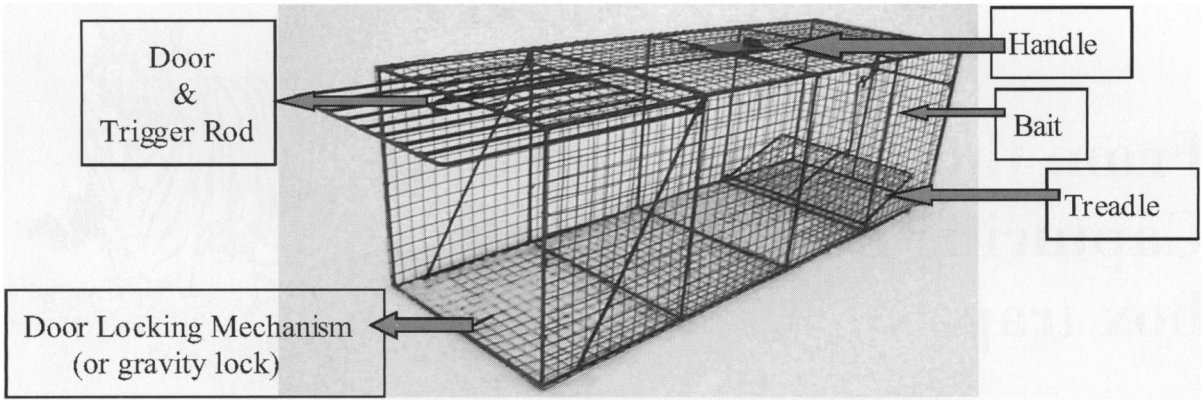

Figure 1. Basic design of a single-door box trap used to capture beavers. Treadle or trip pan is set toward the back, where 20–30-cm-long freshly cut aspen or birch sticks are tied or wired to the mesh. The door-locking pin on the bottom front of the trap would often either not engage or be pushed down by the weight of the beaver, allowing the captive animal to then push open the door and escape.

2001 estimated beaver densities at 0.70, 0.83, and 0.43 active colonies/km^2, east to west, respectively (MDFW, unpublished data).

Methods

We used box traps to capture beavers in April–October 2001–2003. We purchased commercially available box traps from various companies over the internet. Box traps were constructed with metal frames and wire mesh and had single or double doors (Figure 1). Dimensions ranged from 38 × 38 × 122 cm to 48 × 48 × 122 cm for single-door designs, and 40 × 40 × 152 cm for double-door designs. Traps averaged 14.5 kg. In most cases, especially for new traps that were shiny silver in color, we spray painted the entire trap with 2 coats of flat black paint. We also left traps outside to rust. Capture occurs when the beaver steps on a treadle plate and releases the door, which drops and latches closed behind the beaver. In some cases we had to file trigger mechanisms with a flat mill file or grinder to allow them to release more readily; in other cases we had to roughen trigger mechanism surfaces with the edge of a mill file to improve surface contact and prevent them from releasing prematurely with very light pressure or with slight movements of the trap.

We placed box traps along feeding trails, at water's edge, on dams, and in runways (Figure 2*a–c*). We usually used bait (2–4 × 20–30-cm cut aspen [*Populus* spp.], birch [*Betula* spp.], or other available trees) dabbed with commercial scent lure (e.g., castor, food, curiosity), which was hung at the back of the trap behind the treadle plate (single door design) or in the middle of the trap above the treadle plate (double door design). We wore rubber gloves while setting and baiting traps to minimize human odors. At times we set double door traps without bait or scent on dam crossovers, in runways in shallow water, or on travel paths on land to intercept beaver movements. We placed a 4–6-cm-diameter chew stick on the bottom of the trap to provide an extra source for gnawing; this often was an old beaver chewed stick found in the area. As an additional attractant to a particular trap set area, we sometimes used scent lure placed on vegetation several cm in front of the trap and as artificial scent mounds just inside the trap. If available, we would place a handful of mud from a recently made beaver scent mound in the trap along with our commercial lure. We covered the wire floor of the trap with mud and leaf litter to blend with the ground surface and provide more natural footing. We stabilized traps with stakes and wire to prevent them from rolling into deeper water, camouflaged them to decrease human disturbance, and cabled and locked traps to a tree to prevent theft in areas with high human activity (Figure 2*d*). We then doused traps with pond water to mask human scent.

We recorded trap type (single- or double-door) and modifications, trap placement (e.g., ≤3 m near a dam or lodge, along a feeding trail, in a travel channel, or on a dam), date set, and type of bait and scent lure used both in and just outside of the trap. We monitored traps on a daily basis during early mornings and recorded all successful captures and all apparent unsuccessful capture attempts. Evidence for an unsuccessful capture included the door

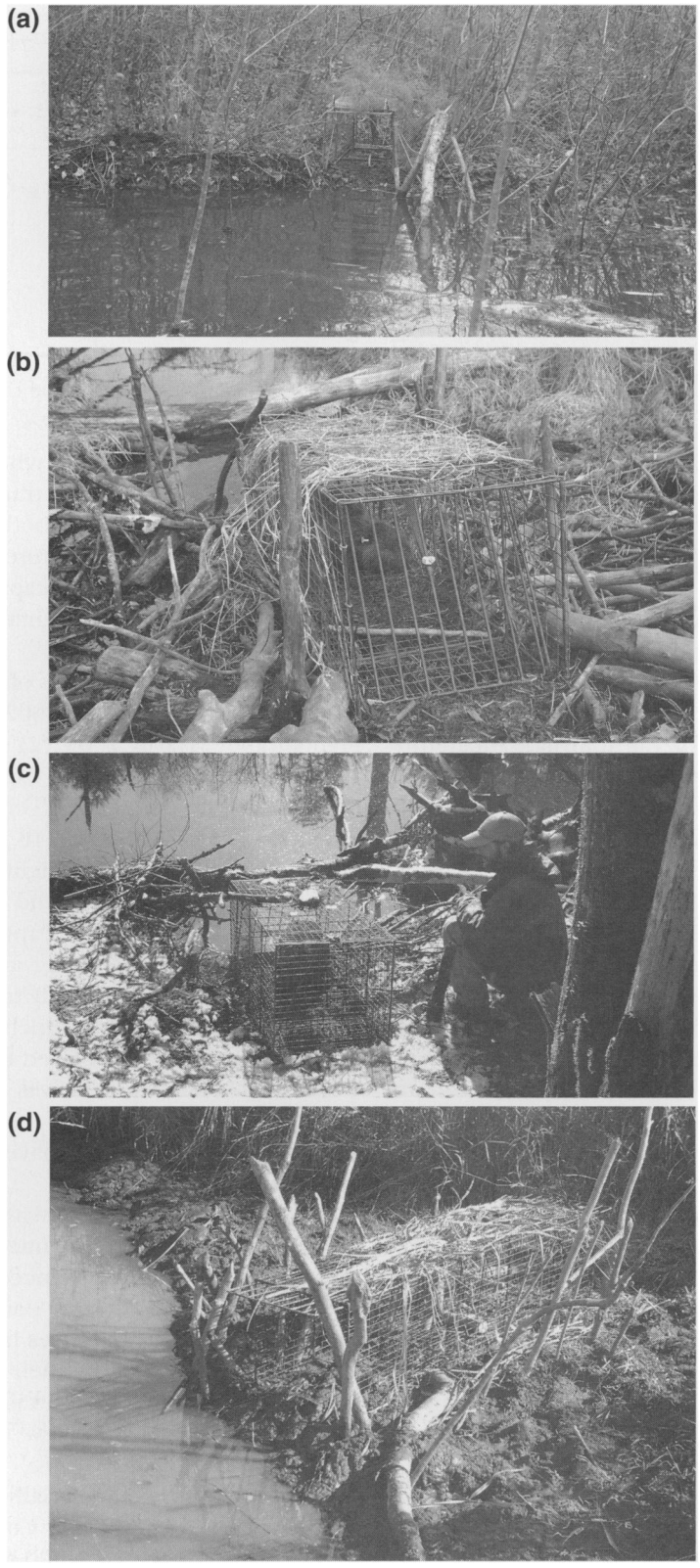

Figure 2. Box traps were used in a variety of sets to capture beavers. (*a*) Baited (aspen sticks and commercial lure) single-door box trap set along beaver feeding trail. (*b*) Unbaited double-door box trap set on dam to intercept movement of beavers at a passage over the dam. (*c*) Single-door box trap set on land at water's edge. (*d*) Box trap secured with stakes to prevent rolling into water.

Figure 3. After handling and marking, beavers were placed back in box traps and moved to a cool, shady place along the water's edge so that the animal could recover from the anesthesia before being released.

closed but not latched, or the trap had apparently been entered (e.g., bait had been eaten or removed, tracks in mud, leaf litter disturbed) but the door did not close (e.g., trigger mechanism not released, door hung up on the cage, debris pushed under the treadle). We defined capture rate as the number of beavers captured in individual traps divided by the number of trap-nights and the rate of unsuccessful capture attempts as the number of apparent unsuccessful captures (based on evidence as stated above) divided by the number of trap-nights.

Captured beavers were immobilized with an intramuscular injection of ketamine hydrochloride (10–13 mg per kg body mass) and acepromazine maleate (2.5 mg) (Lancia et al. 1978). We determined age and sex, and marked individuals with metal and plastic ear tags and a tail-mounted radiotransmitter (Rothmeyer et al. 2002). After marking, we placed beavers back into box traps in a shady protected area near the water and did not release each individual until it fully recovered from the drugs, which we judged based on its alertness, mobility, and ability to hold up its head and move within the box trap (Figure 3).

Results

During 2001–2003, we captured 58 beavers in box traps (Table 1). All captures were of a single beaver with 1 exception, when we captured 2 subadult beavers in 1 box trap. We also had 27 recaptures, which occurred both within and among years (Table 1). We recaptured most individuals only once; however, we recaptured 6 individuals 2–4 times. We had 4 incidental captures of single raccoons.

Table 1. Age and sex of 58 beavers captured in box traps in 2001–2003 and Bailey traps in 2001–2002 in Massachusetts.

	Captures			Recaptures		
Age[a]	Males	Females	Unknown	Males	Females	Unknown
Young of the year	2	2	0	0	0	0
Subadults (1–2 yrs.)	22	9	3	10	6	2
Adults (>2 yrs.)	9	11	0	5	4	0
Total	33	22	3	15	10	2

[a] Age determination based on Patric and Webb (1960).

We recorded capture rates of 11% in 2001 (27 of 244 trap-nights), 11% in 2002 (37 of 351 trap-nights), and 21% in 2003 (21 of 99 trap-nights). When pooled across years, capture rate was 12% (85 of 694 trap-nights). Unsuccessful capture attempts were 4% in 2001 (10 of 244 trap-nights), 7% in 2002 (26 of 351 trap-nights), and 18% in 2003 (18 of 99 trap-nights), and averaged 8% for 2001–2003. Unsuccessful capture attempts were due mainly to doors closing and not latching, or possibly by being accidentally tripped by an animal bumping into the frame, which set off the trigger before the animal had entered the trap. There also were times when the bait was removed and eaten but the treadle did not trip the door release (e.g., kits weighing <6 kg may have been too light to move the treadle).

All beavers were released within 1–2 hours of initial handling; mean holding time was 1 hour 34 minutes. Except for a few instances, the bait placed in box traps was consumed or partially consumed by captured beavers. In all cases beavers went directly into the water toward their lodge shortly after release. We observed no mortality or obvious physical injuries, except for a few minor scratches on 4–5 occasions.

Retail prices for commercially available box traps ranged from $70–100 (U.S.). Costs of modifications were minimal, averaging <$20 per trap, and included spray paint, wire, miscellaneous hardware, and minor welding.

Discussion

Box traps proved to be a viable method for live-trapping beavers of all age and sex classes. Our capture rates for beavers improved from about 11% in 2001–2002 to 21% in 2003; we feel this increase was due to a combination of factors such as modifications that improved door-locking mechanisms and our increased experience with trap placement and setup. These capture rates are comparable to capture rates reported from other studies using Bailey and Hancock traps and snares. For example, Hodgdon (1978) reported an 11% capture rate (125 beavers in 1,165 trap nights) for Hancock traps and 16% (111 captures in 703 trap nights) for Bailey traps. Davis (1984) reported a combined capture rate of 4% for Bailey traps and snares (48 beavers in 1,099 trap nights, with 7% success in Bailey traps and 2% in snares), and McKinstry and Anderson (2002) reported a capture rate of 9% for a combination of Hancock traps and snares. As our capture rate increased over the course of our study, so did the rate of unsuccessful capture attempts. We believe this was due partly to our improved ability to detect unsuccessful captures and to increased visitation by beavers to our traps as we gained more experience.

We found that most traps required some modification and maintenance. Modifications included an improved door-locking mechanism, which consisted of a drop-down bar, designed by John Benedetto (Animal Problem Control, Wakefield, Mass. [Figure 4]), along with weighted and reinforced doors, which served to prohibit beavers from backing out before door locks were set. Heavier doors were particularly important for box traps set in shallow water, such as in runways, because the water would slow or inhibit the door, thus preventing the locking mechanism from engaging. We also found that the weight of larger beavers on the bottom of the trap could force the bottom locking pin (Figure 1) to go below the bottom frame of the door, allowing the beaver to push its way out. Addition of the drop-down bar, and in some cases, removing the bottom pin, corrected this problem. Captured beavers occasionally would damage traps by pulling on the wire mesh, especially with lighter-gauge mesh, and traps would sometimes come out of square because of rough handling. We would check traps and make repairs as we moved to new trapping sites, and all traps would receive maintenance, repair, and new paint as needed before the onset of a new trapping season.

Figure 4. Drop-down bars, designed and installed by J. Benedetto of Animal Problem Control, Wakefield, Massachusetts, often were added to box traps to improve or replace the commercial locking mechanism.

Beavers caught in box traps could groom, keep dry, had room to move around, and could eat and chew on sticks to keep them occupied after capture. Beavers caught in Bailey or Hancock traps are held partially in water, which can cause discomfort and possible exposure to hypothermia (Grasse and Putnam 1950) or drowning (Buech 1983, Davis 1984). Box traps also provided a convenient and safe place for beavers recovering from anesthesia.

We did not have any capture-related mortalities or serious injuries to beavers captured in box traps. We did find information from several other studies on mortalities for beavers caught in snares or Bailey and Hancock traps. In a 5 year study in Wyoming, McKinstry and Anderson (2002) reported that trapping mortality for 277 captured beavers was 4% for snares and 1% for Hancock traps. Mortality was caused by entanglement in snares ($n=11$) or being killed by predators while captured in Hancock traps ($n=4$). In South Carolina Davis (1984) used snares and Bailey traps to capture 48 beavers and had 2 beavers die in snares (1 of respiratory arrest and 1 drowned when the cable got caught on a tree root) and 2 die in Bailey traps (1 due to drowning in rising water after a thunderstorm and 1 died, apparently, of shock). Hodgdon (1978) reported 3 beaver trap-related mortalities using a combination of Bailey and Hancock traps in Massachusetts.

Although box traps could be difficult to carry long distances through dense vegetation, once at the site they were easy to set up. Our set-up times

ranged from 30–40 minutes the first season to 10–15 minutes by the third season. We did not use collapsible box traps because they were not readily available in the sizes we required, and we were concerned about their strength and ability to withstand prying by captive adult beavers. Box traps also posed no safety concerns for trappers and did not require any special training to operate. Instructions provided with Bailey and Hancock traps recommend users wear a helmet while setting the trap. Because of trapper safety concerns, Massachusetts trappers are required by law to attend a special session on the set-up and safe use of Bailey and Hancock traps.

Recommendations

We recommend purchasing large (48 W × 48 H × 122 L cm for single door; 152 L cm for double doors) higher-end ($100) traps constructed with sturdy frames and heavy wire mesh. These traps weigh more but will require fewer repairs and less maintenance. A few smaller traps can be used for less accessible wetlands. Smaller mesh dimensions (2–3 × 2–3 cm) will prevent tail-mounted radiotransmitters from getting caught when marked beavers are recaptured. Having both single- and double-door models will allow flexibility in trap sets; double-door traps will need to be longer than single-door traps to prevent doors from closing onto the beaver's back or tail, thus allowing escape. Major modifications likely will include refinement of the trigger mechanism (e.g., filing and adjustments to allow smooth operation), installation of the drop-down bar locking mechanism (Figure 4) and perhaps removal of the bottom locking pin (if necessary), and 1–2 coats of flat black spray paint. In addition, because most box traps did not have special access for adding bait, it was awkward and time-consuming to place bait securely at the back of the trap beyond the treadle (in 1-door models) or in the middle of the trap above the treadle (in 2-door models). The addition of a small door to the top of the trap improved access to the interior for bait placement and shortened set-up time.

Searching for recent sign (fresh chews, scent mounds, new mud on dams and lodges, animal sightings) is the first step in choosing trap sites. Box traps can then be placed at water's edge, particularly where there is evidence of recent feeding, in shallow channels, on dams where beavers cross over, and near lodges. Check with local natural resource agencies to be sure that regulations are followed or exemptions are approved (e.g., training requirements, trap sizes). Freshly cut aspen sticks, with some of the bark sliced off and placed in the trap, along with any commercial or homemade scent, worked well as bait and attractant; aspen was best, but birch and willow (*Salix* spp.) would work. We could capture beavers throughout the spring, summer, and autumn, but box traps were most effective in early spring before the growth of aquatic vegetation, and then again in fall when beavers were focused on collecting woody growth for their winter caches. Our findings provide information for research involving beavers and also for animal control agents and recreational trappers working under new trap restrictions in states like Massachusetts.

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Literature cited

BUECH, R. R. 1983. Modifications of the Bailey live trap for beaver. Wildlife Society Bulletin 11:66–68.

DAVIS, J. R. 1984. Movement and behavior patterns of beaver in the Piedmont of South Carolina. Thesis, Clemson University, Clemson, South Carolina, USA.

GEHRT, S. D, AND E. K. FRITZELL. 1996. Sex-biased response of raccoons (*Procyon lotor*) to live traps. American Midland Naturalist 135:23–32.

GRASSE, J. E., AND E. F. PUTMAN. 1950. Beaver management and ecology in Wyoming. Wyoming Game and Fish Commission Bulletin 6. Laramie, USA.

HODGDON, H. E. 1978. Social dynamics and behavior within an unexploited beaver (*Castor canadensis*) population.

Dissertation, University of Massachusetts, Amherst, USA.

KAMLER, J. F., W. B. BALLARD, R. L. GILLILAND, AND K. MOTE. 2002. Improved trapping methods for swift foxes and sympatric coyotes. Wildlife Society Bulletin 30:1262–1266.

KOLBE, J. A., J. R. SQUIRES, AND T. W. PARKER. 2003. An effective box trap for capturing lynx. Wildlife Society Bulletin 31:980–985.

LANCIA, R. A., R. P. BROOKS, AND M. W. FLEMING. 1978. Ketamine hydrochloride as an immobilant and anesthetic for beaver. Journal of Wildlife Management 42:946–948.

MACCONNELL, W. P., D. W. GOODWIN, AND K. M. L. JONES. 1991. Land-use update for Massachusetts with area statistics for 1971 and 1984/1985. Massachusetts Agricultural Experimental Station, Research Bulletin 740. University of Massachusetts, Amherst, USA.

MASSACHUSETTS MUNICIPAL ASSOCIATION. 1995. Massachusetts Municipal Profiles 1995–1996. Boston, USA.

MCKINSTRY, M. C., AND S. H. ANDERSON. 2002. Survival, fates, and success of transplanted beavers, *Castor canadensis*, in Wyoming. Canadian-Field Naturalist 116:60–68.

MOWAT, G., B. G. SLOUGH, AND R. RIVARD. 1994. A comparison of three live capturing devices for lynx: capture efficiency and injuries. Wildlife Society Bulletin 22:644–650.

PATRIC, E. F., AND W. L. WEBB. 1960. An evaluation of three age determination criteria in live beavers. Journal of Wildlife Management 24:37–43.

POWELL, R. A., AND G. PROULX. 2003. Trapping and marking terrestrial mammals for research: integrating ethics, performance criteria, techniques, and common sense. ILAR (Institute for Laboratory Animal Research) Journal 44:259–276.

ROSELL, F., AND B. HOVDE. 2001. Methods of aquatic and terrestrial netting to capture Eurasian beavers. Wildlife Society Bulletin 29:269–274.

ROSELL, F., AND J. K. KVINLAUG. 1998. Methods for live-trapping beaver (*Castor* spp.). Fauna-Norvegica Series A 19:1–28.

ROTHMEYER, S. W., M. C. MCKINSTRY, AND S. H. ANDERSON. 2002. Tail attachment of modified ear-tag radio transmitters on beavers. Wildlife Society Bulletin 30:425–429.

WAY, J. G., I. M. ORTEGA, P. J. AUGER, AND E. G. STRAUSS. 2002. Box-trapping eastern coyotes in southeastern Massachusetts. Wildlife Society Bulletin 30:695–702.

WESTVELD, M., R. I. ASHMAN, H. I. BALDWIN, R. P. HOLDSWORTH, R. S. JOHNSON, J. H. LAMBERT, H. J. LUTZ, L. C. SWAIN, AND M. STANDISH. 1956. Natural vegetation zones of New England. Journal of Forestry 54:332–338.

WHITE, P. J., T. J. KREEGER, U. S. SEAL, AND J. R. TESTER. 1991. Pathological responses of red foxes to capture in box traps. Journal of Wildlife Management 55:75–80.

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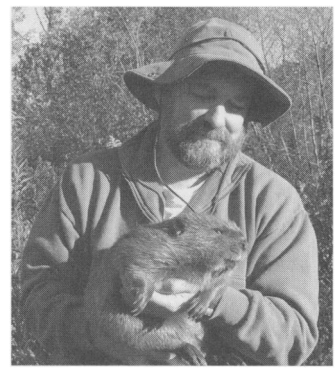

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