Wildlife Session

Evaluation of an Outdoor Facility for Maintaining Wild Raccoons

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Abstract: Up to 10 raccoons (*Procyon lotor*) were live-trapped and held within covered wire cages for about 1 month each season during June 1988–August 1989. Animals were fed 250–300 g of dry dog food daily and provided water ad libitum; percent change in body mass during captivity was used to evaluate the response of raccoons to the holding facility and maintenance protocol. Change in body mass at release varied from −0.6 kg to 1.6 kg. Daily percent change averaged 2.7%; the largest total percent change in body mass of 70%. Percent change in body mass was independent of retention time, previous experience, age, sex, or season. The facility appeared to provide effective temporary housing as none of the animals were injured, nor was there any evidence of captive-related trauma or unusual behavior during captivity or following release.

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Field experiments involving manipulation of natural populations are an increasingly common approach to testing hypotheses (Green 1979). Also, translocation of wildlife species has become a successful means of re-establishing viable populations within historic range (Clark 1987, Phillips and Parker 1988). In addition, scientists are under increasing demands to justify biological studies with animals and ensure humane treatment. However, accounts of maintaining wild, medium-sized mammals in captivity are few (Crandall 1964, Sieber 1984). This paper describes procedures, facilities, and the response and general welfare of raccoons (*Procyon lotor*) during captivity.

As part of a field experiment to assess the behavioral response of raccoons to change in density, raccoons were removed from an island population and held at a

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field station on the mainland for about a month each season (spring, Mar.–May; summer, Jun.–Aug.; fall, Sep.–Nov.; winter, Dec.–Feb.). The objective was to minimize stress and other possible deleterious effects of captivity so that reintroduced raccoons would show little or no effects of being retained.

U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) regulations for outdoor facilities, space requirements, feeding, watering, sanitation, employees, separation, veterinary care, and handling for warmblooded animals other than dogs were followed as closely as possible during facility planning, animal handling, and animal retaining periods (U.S. Dep. Agric. APHIS 1985, U.S. Dep. Health and Human Serv. 1985). Additionally, specific research concerns included providing a quiet, clean and comfortable environment; maintaining the weight of animals; and preventing injuries or other debilitating conditions (e.g., disease).

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Methods

A 6.1 x 6.1 m outdoor facility was constructed within a secluded portion of Tech Aqua Biological Field Station at Tennessee Technological University that received protection from wind, direct sunlight, and human disturbance. Two rows of 5 cages were placed on concrete blocks that were embedded within an 18-cm substrate of crushed limestone.

Each cage consisted of 2.5 x 5.0 cm mesh, 0.14 gauge welded wire attached with hog rings to a steel frame (1.2 x 0.9 x 1.2 m) of 1.3-cm diameter reinforcement rod (Fig. 1). Each cage was covered with corrugated tin sheets and had a 50 x 90 cm entrance gate. A 61 x 61 x 50 cm pine wood den box was attached at the rear of each cage with a 30 x 30 x 50 cm entrance tunnel. Each den box had a 70 x 70 x 10 cm removable wooden lid covered with asbestos roofing material. Wooden drop gates through entrance tunnels restricted animal movement while den boxes or cages were cleaned (Borden 1990, Borden and Smith 1990). The outside of the den boxes, lids and both sides of the drop gates were painted with white exterior paint to prevent deterioration and help with sanitation.

Raccoons were trapped with baited Havahart (18 x 18 x 76 cm) and Tomahawk (23 x 23 x 66 cm) live traps. Prior to handling, each animal was immobilized with 9:1 mixture of ketamine hydrochloride and acepromazine at a rate of 0.2 mg/kg of body mass using a 1-cc tuberculin syringe (Endres 1989, Borden 1990). Individual raccoons were identified with ear tatoos. Each animal was examined, measured, and weighed by the student researcher immediately following capture and again prior to release. Upon initial examination, each raccoon was aged according to tooth wear

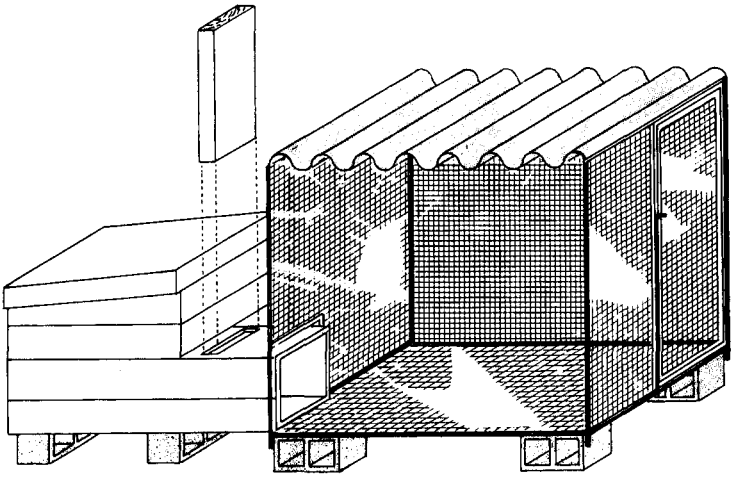

Figure 1. Diagram of individual raccoon cage with removable den box and drop gate. Two rows of 5 cages each were placed on concrete blocks embedded in a crushed limestone substrate, Tech Aqua Upper Cumberland Biological Field Station, Tennessee Technological University.

(Grau et al. 1970). During captivity each raccoon occupied a separate cage. Animal handling was limited to capture and release periods only.

The facility, including food and water pans, was cleaned daily, using a cold water hose, scrub brush, and clorox bleach as a disinfectant. Straw bedding material was replenished in den boxes weekly. Old straw was placed on a compost pile about 15 m away from the facility. Approximate disturbance time to replenish straw was 10 minutes. All animal care was provided by the primary author or 1 of 2 trained care assistants. Visual observations of each animal were made during the bedding replenishment periods to assure no physical injury or visible illness had overcome them. No illnesses or physical injuries were observed.

Raccoons received 250–300 g dry dog food each day: 21% protein (Big Red Nuggets, Pro-Pet, Inc., Newark, Del.) during autumn and 25% protein (Action-Ration Dog Food, Tennessee Farmers Cooperative, Smithville, Tenn.) during winter, spring and summer. Water was provided ad libitum. Percent change in body mass (change in body mass divided by the initial mass $\times$ 100%) during captivity and behavior following release were used to assess response to captivity.

Spearman rank correlation analysis (Zar 1984) was used to determine whether average percent change in body mass per day was related to retention time. The Mann-Whitney tests (Zar 1984) was used with 2-sample comparisons. A nonparametric 2-way ANOVA (Zar 1984) was used to determine whether percent change in mass per day was influenced by sex or season. A probability of <0.05 was accepted as statistical justification for rejecting the null hypothesis.

Results and Discussion

Thirty raccoons were retained for a total of 1,032 animal days. They consumed about 270 kg of dry dog food and used 8 bales of straw as bedding material. The cost of maintaining animals, including the cost of the facility averaged $2/animal/day. A list of supplies and costs is given in Table 1.

Retention time ranged from 7 to 46 days; 70% of the raccoons were kept in captivity ≥30 days (Table 2). While in captivity, change in body mass varied from −0.6 kg to 1.6 kg; 2 raccoons maintained initial mass throughout their retention period. The largest total change (70%) and largest average daily change (2.7%) in percent body mass was exhibited by an age-class II (15–38 months old) male during summer. The largest total decrease (−9.0%) and daily decrease in body mass (−0.86%) occurred during fall to an age-class III (39–57 months old) male and an age-class II male raccoon, respectively. Change in body mass was independent of age ($H = 0.27$, df = 4, $P > 0.99$).

At the end of the fall retention period, half the animals increased body mass while the others experienced a decrease (Table 2). However, net daily change in percent body mass for captive raccoons was negligible (0.008%). Conversely, daily change in body mass during winter, spring, and summer increased an average of 0.14%, 0.38%, and 1.47% per animal, respectively. Daily change (%) in body mass was not correlated with retention time during fall ($r_s = 0.29$, $P > 0.50$), winter ($r_s = 0.15$, $P > 0.50$), or spring ($r_s = -0.1$, $P > 0.50$). In summer, males that were retained for shorter periods experienced a greater increase in percent body mass ($r_s = -1.0$, $P = 0.02$). Percent change in body mass was similar between experienced raccoons (i.e., previously captured and retained) and first-time (naive) captives ($U = 92$, $P > 0.10$). Median daily change in body mass of naive ($N = 25$) and experienced ($N = 5$) animals was 0.29% and 0.53%, respectively.

Average percent change in body mass of all captive raccoons was similar between sexes ($H = 2.42$, df = 1, $P > 0.10$). Body mass of both sexes may have been influenced by season (except summer when we had no data for females), but our computed statistic fell outside the critical value ($H = 5.17$, df = 2, $0.05 < P < 0.10$). When we included the summer data for males, however, a Kruskal-Wallis 1-way ANOVA (Zar 1984) revealed that change in body mass differed among seasons ($H = 13.2$, df = 3, $P < 0.01$) with males during summer showing significant increases in percent body mass as compared to captive raccoons during fall ($Q = 3.40$, $P < 0.05$; Tukey-type test, Zar 1984) and winter ($Q = 2.83$, $P < 0.05$). There was no apparent interaction of sex and season ($H = 1.75$, df = 2, $P > 0.25$) which was somewhat surprising as we expected pregnant females to experience an increase in body mass during late spring and into summer (Kaufmann 1982). It is possible that because of small sample sizes, individual variation may have confounded our attempt to distinguish significant biological phenomena. Nonparametric statistical analyses are generally less powerful and thus the probability of a Type II error is typically greater than with parametric analogs.

Placing cages on concrete blocks presumably improved ventilation and facili-

Table 1. Outdoor raccoon facility supplies and costs.

Supply item and amount	Cost	Total
20 Food and water pans	3.00/each	60.00
1 Water hose	40.00/each	40.00
8 Bails straw	2.00/each	16.00
7000 kg crushed stone	98.00/total	98.00
7- 11.35 kg bags of Big Red dog food	6.00/each	42.00
4- 22.70 kg bags of Action Ration	10.00/each	40.00
1- 113.55 liter storage can with lid	10.00/each	10.00
7.57 liters white paint	8.30/each	16.60
60 concrete blocks	donated	—
12 sheets of .7625m x 3.66m tin	donated	—
	Subtotal	$ 322.60
1 Wire cage:		
1- .4064m x .1016m piece of wire	$ 2.00/meter	32.00
29.89m concrete reinforcement rod	$ .30/meter	29.40
1 box hog rings	$ 3.00/box	3.00
Labor cost	$20.00/each	20.00
	Subtotal	$ 84.40
	(x 10)	$ 844.00
1 Wooden den box:		
18.288m - 2.540cm x 15.24 white pine boards	$ .49/meter	29.40
.227kg of 1.27 cm roofing nails	$ 1.20/kg	.60
.454kg of # 8 nails	$ .80/kg	.80
.61m x .915m asbestos roofing material	$ .60/meter	3.60
Labor cost	$20.00/meter	20.00
	Subtotal	54.40
	(x 10)	$ 544.00
Total cost supplies and construction		$1,710.60

Table 2. Percent change in body mass (change in body mass to the nearest 113.4 g divided by initial body mass X 100%), initial body mass (kg), and retention time (days) for captive wild raccoons, Central Basin, Tennessee, June 1988–August 1989.

Fall			Winter			Spring			Summer		
%	(kg)	Days	%	(kg)	Days	%	(kg)	Days	%	(kg)	Days
Males											
17	(2.7)	45	− 4	(6.4)	46	21	(3.9)	40	33	(3.4)	30
− 9	(6.4)	45	− 5	(4.8)	45	26	(4.4)	38	43	(3.2)	29
− 8	(5.9)	45	17	(2.7)	44	11	(3.2)	37	33	(2.7)	32
− 6	(5.7)	7	− 8	(4.5)	38	0	(3.9)	20	33	(2.4)	31
			17	(2.7)	35				70	(2.3)	26
			17	(5.4)	32						
			0	(4.5)	28						
Females											
17	(3.6)	44	8	(2.9)	46	18	(3.2)	43			
13	(4.1)	25	4	(3.2)	31	9	(3.6)	41			
			3	(3.6)	29	11	(4.0)	38			
						17	(2.0)	22			
						12	(2.9)	20			

tated removal of waste food and feces, which fell easily through wire openings. At the end of each temporary holding period, all cages and boxes were dismantled, disinfected and left to dry in the sun for several days before reassembling. Cleanliness ultimately reduced problems with flies and exposure to parasites and diseases.

Our holding facility seemingly provided effective, temporary housing for raccoons. None of the retained animals were injured, nor was there any evidence of other capture-related trauma. According to our telemetry observations, no discernible difference in behavior occurred between reintroduced retainees and resident raccoons (Borden and Smith, unpubl. data).

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