EFFECTS OF AVERSIVE CONDITIONING ON BEHAVIOR OF NUISANCE LOUISIANA BLACK BEARS

A Thesis

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by
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DEDICATION

This work is dedicated to a great friend and father figure, Randall "Randy" J. Choate, who lost his battle with lung cancer as this project neared its completion. I had the honor of working with and befriending Randy, a Wildlife Specialist for the United States Department of Agriculture, who unselfishly dedicated his remaining time to saving countless lives in New Orleans in the aftermath of Hurricane Katrina, only to lose everything he owned in the wake of Hurricane Rita. Even with this great personal loss his will to help others continued as he rescued neighbors, pets, horses, cattle, and other displaced livestock for weeks after Rita struck the heart of Cajun country, countless lives have been touched by Randy's brief visit of 56 years; his generosity, enthusiasm, cunning sarcasm, devotion, and love will be missed immeasurably.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Consistent habitat loss and fragmentation are contributing factors to the rise of human-bear conflicts in south Louisiana. Complaints associated with nuisance activities of Louisiana black bears *(Ursus americanus luteolus)* experienced in this region have steadily increased since 2000, requiring intervention by state and federal agencies. As a threatened species, Louisiana black bears require non-lethal management referred to as aversive conditioning. We used rubber buckshot and dogs to test the effectiveness of management techniques used by the state to deter nuisance activity by black bears. Eleven bears, representing approximately 15% of the estimated population in this region, were captured in residential and industrial areas reporting nuisance activity. Bears were fitted with radio-transmitting collars and released within 2 km of the capture site. Each bear was randomly placed within 1 of 2 treatments; treatment 1 (n=5) used rubber buckshot and treatment 2 (n=6) used the rubber buckshot in combination with dogs. Bears were monitored using telemetry to estimate movements and interactions with anthropogenic resources. Bears, on average, remained within 2 km of capture sites 2 weeks following release. Ten bears (91%) returned to nuisance behavior within 5 months, regardless of treatment. Results suggest that aversive conditioning techniques used to deter bears from nuisance activity have limited short term effectiveness.

INTRODUCTION

The Louisiana black bear (*Ursus americanus luteolus*), one of sixteen recognized subspecies of the American black bear (Hall 1981), was once distributed throughout Louisiana, south Mississippi, and east Texas, but now has been restricted to 3 isolated subpopulations in Louisiana due to habitat loss and overexploitation. One of the existing subpopulations of bears resides in St. Mary, Iberia, and Vermillion Parishes in the coastal freshwater marshes and lowland forests of the lower Atchafalaya River Basin (ARB) Complex. Consistent habitat loss, high-speed roadways, and sprawling urban and suburban development place many bears in this region close to humans, where conflicts inevitably arise. Louisiana Department of Wildlife and Fisheries (LDWF) reports of complaints associated with nuisance activity in this area have steadily increased since 2000, requiring greater state and federal intervention.

As a threatened species listed under provision of the Endangered Species Act (ESA) in 1992, Louisiana black bears are federally protected and require non-lethal management. The LDWF and U.S. Department of Agriculture (USDA) Wildlife Services, in response to increased bear-human conflicts, implemented a commonly used technique referred to as aversive conditioning. Aversive conditioning is a method designed to provide the offending animal, in this case nuisance black bears, with a negative experience using various deterrent measures like rubber buckshot, loud noise, and dogs to discourage nuisance behavior.

In recent years both LDWF and USDA began experimenting with dogs, specifically black-mouthed curs, coupled with rubber buckshot to further deter problem bears from continuing nuisance behavior. LDWF reported favorable results (i.e., reduction in reports of reoccurring nuisance activity) since implementing the use of dogs. In April 2005 we began trapping, radio collaring, and monitoring nuisance black bears in areas of St. Mary, Iberia, and

Vermillion parishes reporting nuisance activity to test the effectiveness of these management techniques.

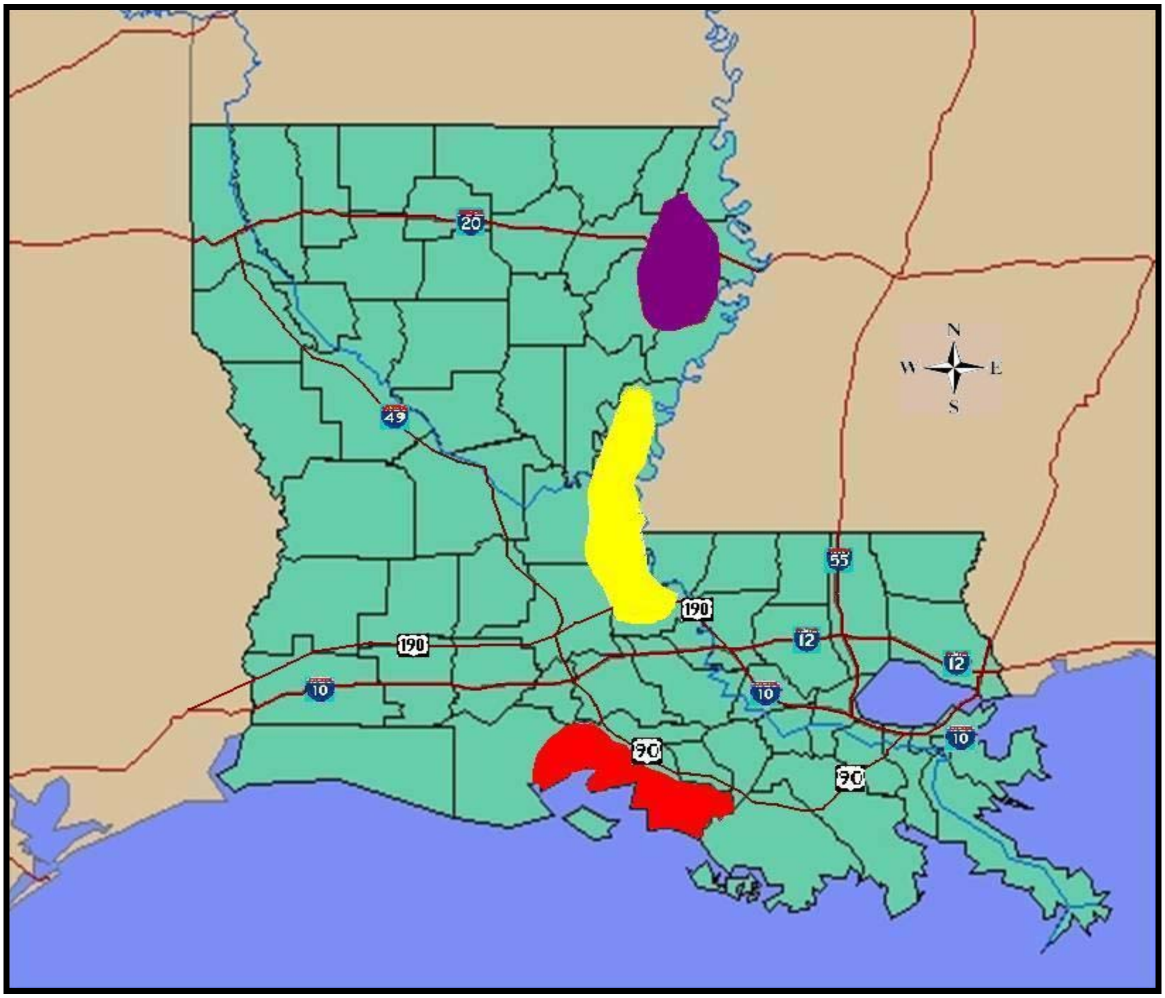
Objectives

The goal of this research is to assess the effectiveness of aversive conditioning methods by examining space use, movements, and interactions with urban and anthropogenic resources following release and conditioning of bears. Such evaluation will provide information on bear behavior following conditioning, ultimately indicating the effectiveness of individual (rubber buckshot) and combined techniques (rubber buckshot and dogs) used to deter nuisance black bear activity in this region.

STUDY AREA

This study was conducted in the Atchafalaya River Basin (ARB) of south –central Louisiana (Figure1). The basin is segmented into four subunits: upper (above U.S. highway 190), middle (between highway 190 and interstate 10), lower (between I-10 and U.S. highway 90), and coastal regions (South of highway 90). We concentrated the study in the Coastal ARB region of Louisiana in St. Mary, Iberia, and Vermilion Parishes, which encompassed 6112 km^2 of freshwater marshes and bayous, lowland cypress-gum forests, agriculture and farm lands, industrial, recreational (private and public), and residential areas. St. Mary and Iberia Parishes, which contained the highest concentration of black bears in the Coastal ARB region, encompassed 3074 km^2 (759,602 acres) of mixed bottomland forests, cypress-tupelo swamp, bayous, and man-made canals, farm and agriculture lands, industrial properties (oil, gas, steel, and salt production and refinery), and rapidly expanding recreational and residential areas that hosted a human population of 125,804 (U.S. Census Bureau 2005) and an estimated abundance of 77 $\pm$ 9 bears (Triant et al. 2004). Vermilion Parish, which encompassed nearly the same area as St. Mary and Iberia Parishes combined (3038 km^2 / 750,706 acres), hosted a population of 55,195 people. The landscape was dominated by lowland forests, marshes, and highly erodable soils used predominately by oil and gas companies, farmers, and ranchers. Sparse residential and recreational areas occupied the more developed northern portions of Vermilion Parish.

The Bayou Teche National Wildlife Refuge (NWR) located in St. Mary Parish was composed of 37 km^2 (9028 acres) of designated black bear habitat (U.S. Fish and Wildlife Service). The refuge, like much of the study area, is fragmented by improved and unimproved roadways that present bears in this region with the greatest obstacle when traversing their home



3 EXISTING SUBPOPULATIONS AND STUDY AREA

- Tensas RB Subpopulation
- Red River Complex and Inland ARB Subpopulation
- Coastal ARB Subpopulation (Study Area)

Figure 1. 3 existing subpopulations of Louisiana blacks bears: Tensas River Basin, Red River Complex and Inland (Upper and Middle regions) Atchafalaya River Basins (ARB), and Coastal ARB (Study Area).

ranges in search of food. Roadways like U.S. highway 90 (future corridor for I-49) are major contributors to black bear mortality in the study area (Pace et al. 2000).

Habitat degradation is evident throughout the study area where the emergence of golf courses and parks, subdivisions, and shopping centers rapidly encroach into once historic bear habitat, escalating bear-human interaction due to the subsequent loss of natural food items and the increasing presence of refuse generated by humans (Rogers et al. 1976, Singer and Bratton 1980, Nyland 1995). Man-made channels and canals like the Gulf Intracoastal Waterway (GIWW), in addition to pipelines and levees created by oil and gas companies and the U.S. Army Corps of Engineers further degrade and fragment habitat throughout the region. Industrial areas such as oil, gas, and salt plants are prominent components on Louisiana's coastal landscape that contribute greatly to the region's economy, supplying jobs to thousands of local and transient contractors. Consequently large amounts of trash are generated, causing bears to become highly habituated to human contact (Nyland 1995). Agriculture and farm land encompass a large proportion of the study area, specifically soy beans (yielding an average of 37 net tons per/ acre), sugar cane (23.4 net tons/ acre), rice (5570 net pounds/ acre), and cattle production (41,000 heads/ year). Sugar cane is the only agriculture crop that benefits bears in this region, providing an alternate food source in the growing season; in addition to providing escape cover and corridors to fragmented habitat throughout the coastal region.

Seasonal flooding in this region (essential for many flora, fauna, and fish species) is dependent on monthly participation, which varied during the study: 11.9 cm (Jan-Mar), 8.7 cm (Apr-June), 15.3 cm (July-Sept), and 5 cm (Oct-Dec). Monthly average temperature in the study area ranged from 14.5°C (Jan-Mar), 23.5°C (Apr-June), 28.2°C (July-Sept), and 16.9°C (Oct-Dec). Natural disturbances, like hurricanes and tornados, alter coastal landforms, vegetative cover, water quality, and other vital resources. During my study, Hurricane Katrina (Category 5, downgraded to 3 upon landfall) struck the Louisiana coast line 90 miles east of the study area on 29 August 2005, causing lowland flooding and nominal damage to resources and man-made structures within the study area. On 24 September 2005, Hurricane Rita (also Category 5, downgraded to Category 3), the strongest hurricane ever observed in the Gulf of Mexico, pounded Louisiana's west coast with tidal surges > 10 ft (3.05 m) and winds in excess of 100 mph, significantly altering natural and anthropogenic resources throughout southern portions (<32 km south of U.S. highway 90) of the study area.

METHODS

Black Bear Capture and Handling

Black bears were captured from April 2005 to February 2006 in areas of St. Mary, Iberia, and Vermilion Parishes (Figure 2) reporting nuisance activity to LDWF using a combination of culvert traps and modified Aldrich snares (Johnson and Pelton 1980). Bears were chemically immobilized with an intramuscular injection of Telazol® (Fort Dodge Animal Health, Fort Dodge, Iowa, USA), hydrated with 1.5 cc H_2O (4-5 mg/kg), delivered by blow dart or CO_2 gun. Adult and subadult bears (males > 70 kg and females > 45 kg) were fitted with mortality-sensitive radio collars (Advanced Telemetry Systems) with break away leather spacers and marked with ear tags and corresponding lip tattoo and pit-tag microchip (injected under the skin between shoulder blades) identification numbers. In addition to recording body measurements and weight; blood, tissue, and hair samples were collected for DNA analysis on all bears captured. Tooth wear, body size, and condition were used to estimate age, and in some cases the first pre-molar was extracted for precise age determination by counting cementum annuli on laboratorial sectioned teeth.

Aversive Conditioning and Telemetry

Following work-up, bears were placed in culvert traps where they were allowed to fully recover (for up to 24 hrs.) at the capture site. Once recovered, each bear was placed within 1 of 2 treatments upon release. Bears were assigned treatments by initially choosing one at random and then allocating them systematically thereafter to ensure balance in the number of bears assigned to each treatment. Bears assigned to Treatment 1 were conditioned upon exit from the trap with 12 Gauge rubber buckshot (Less Lethal Wildlife Control Lightfield Ammunition, Freehold, New Jersey, USA), loud voices, and excessive noise. Bears assigned to Treatment 2 were conditioned using the same methods in combination with being chased by dogs (black-mouthed curs) until the bear was confirmed by telemetry to have left the affected area. Attempts were made to recapture bears exhibiting reoccurring nuisance behavior; successfully recaptured bears were reconditioned using Treatment 2 (with dogs) protocol regardless of the initial treatment used. Reoccurring nuisance (RoN) bears that could not be recaptured were reconditioned using Treatment 1 (without dogs) methods when observed displaying nuisance behavior. Treatment effectiveness was measured in time (number of days) bears stayed away from nuisance activity, in addition to the distance bears moved away from capture sites following conditioning.

All bears were monitored intensively with radio-telemetry (using ATS R4000 receiver and Telonics RA-14 H-antenna) following their release to estimate movements, space use, survival, and interactions with anthropogenic and urban resources in their environment (Taylor 1971, Schmutz and White 1990). Each bear was located once per hour during the first 4 hours after their release, then once every 4 hours for the first 24 hours following release. Monitoring intensity subsequently declined during periods following release, unless the individual exhibited reoccurring nuisance behavior. The monitoring protocol > 48 hours following release included 4 locations/bear/day recorded during days 2-7, 2 locations/bear/day during days 8-14, 3-5 locations/bear/week during days 15-90, and occasional (several times monthly) locations thereafter to document survival and location relative to human activities. All locations were distributed throughout the diel period to monitor movements during diurnal and nocturnal periods. Locations were derived from bearings taken at temporary and fixed stations using a Global Positioning System (GPS) in Universal Transverse Mercator (UTM) coordinates. Locations were triangulated using field maps to ensure accuracy during data collection, and then triangulated using radio-telemetry based software (Locate II and LOAS 3.2 Ecological Solutions Software, Urnäsch, Switzerland) for precise location and relative error estimation. Only bear locations meeting the following criteria were used for analyses: (1) Locations derived by using ≥ 3 bearings, (2) All bearings collected within 20 minutes, (3) Angles between consecutive bearings ≥30º, (4) Angles between the 2 outermost bearings ≤145º (Benson 2005).

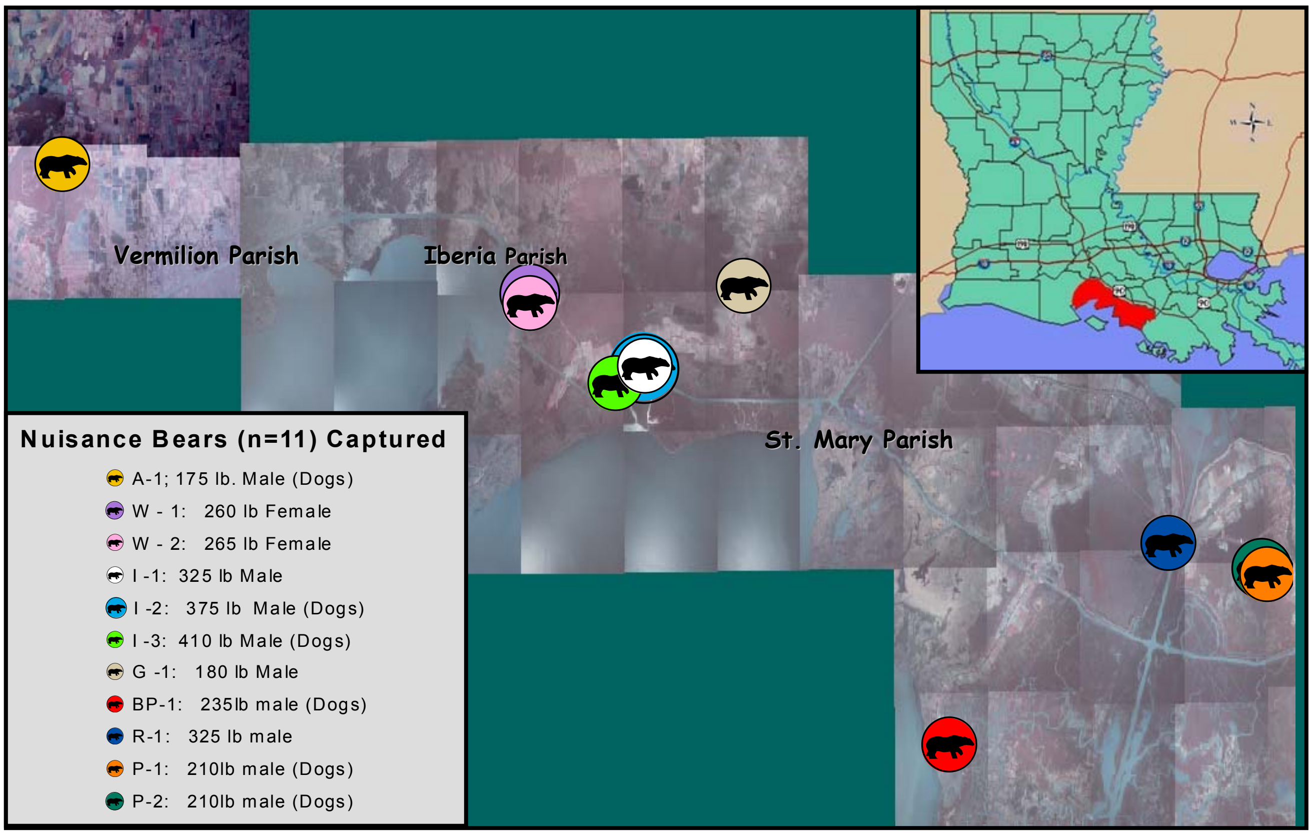


Figure 2. Nuisance bear capture sites (parentheses in legend denotes type of treatment used) in Vermillion, Iberia, and St. Mary Parishes of southern Louisiana, 2005-06.

HOMERANGE AND SPACE USE ESTIMATION

I used 790 locations distributed among 11 bears (9 male and 2 female) collected from April 2005 to July 2006 to estimate home range and core area sizes, distance moved from capture sites during the first 24 hours and 2 weeks following release, and total distance bears moved during the entire study. Movements between consecutive locations were estimated to evaluate the amount of movement within each bear's range following conditioning and release, providing insight into how bears traversed their home range and interacted with anthropogenic resources. To evaluate home range and core area sizes, I estimated 95% home ranges (HR_{95}) and 50% core areas (HR_{core}) using fixed kernel estimators (Seaman and Powell 1996, Powell et al. 1997) for each bear in the Home Range, Animal Movement, and Spatial Analyst Extensions in ArcMap 9.1 (Environmental Systems Research Institute, Redlands, California, USA). To compare home range size with previous research conducted in the same study area (Wagner 1995), I used MCP Analysis Tools from the Home Range Extension in ArcMap 9.1 to derive minimum convex polygons (HR_{MCP}) for each bear. To estimate mean distance bears moved from capture sites during the first 24 hours and 2 weeks following release, I spatially joined telemetry locations of each bear for each time period to respective capture sites using ArcMap 9.1. The same method was conducted using locations collected during the entire study to estimate overall mean distance bears moved from capture sites in addition to estimating relative mean distance bears moved between consecutive locations. To further evaluate movement patterns for each bear I converted locations to paths for each period using Animal Movements from Hawths tools in ArcMap 9.1. I evaluated possible interactions with anthropogenic resources by dividing the number of bear locations found within 1 km of urbanized areas by the overall number of locations collected during the entire study. I additionally calculated percentage home range and core area overlap for each bear to investigate how habitual behavior influences interaction with other bears captured in the same area by using the same method to calculate percentage space use overlap for each bear exhibiting home range and/or core area overlap. Locations found inside other bear home ranges and/ or core areas were divided by total number of locations collected (Chamberlain and Leopold 2000).

ANALYSIS

All statistical analyses were conducted using SAS 9.1 (SAS Institute, Cary, North Carolina, USA). I used *t*-tests to evaluate differences in mean home range (HR_{95}) and core area (HR_{core}) size between treatments among all bears captured. I additionally used a 2-tailed *t*-distribution to test differences in mean home range (HR_{MCP}) size between male bears (non-nuisance) captured in my study area from 1992 to 1994 (Wagner 1995) and male nuisance bears captured during my study; female bears were ignored due to the disproportionate number of females captured in each study (Wagner $n=20$ and Leigh $n=2$). Due to a small sample size, least squared estimates with confidence intervals (95% about the mean) were used to investigate differences between treatments based on mean distances all bears moved from capture sites for:

(1) periods of 24 hours and 2 weeks following release;

(2) periods until bears were observed displaying RoN behavior;

(3) the entire study;

RESULTS

Home Range

Home range (HR_{95}) and core area (HR_{core}) size did not differ between treatments for all bears captured (HR_{95}: $t_{df=9} = -0.89$, $P_{df=9} = 0.40$ and HR_{core}: $t_{df=9} = -0.62$, $P_{df=9} = 0.55$) (Table 1). Mean home range and core area sizes for males (12.7 km^2) were noticeably larger than females (0.86 km^2); however, no statistical analysis was conducted between sexes due to the unbalanced ratio of females *(n=2)* to males *(n=9)* captured during the study.

Table 1. Home range sizes and core area (km^2) among treatments used to deter nuisance black bear activity in southern Louisiana, 2005-06.

	Home Range (HR_{95})				**Core Area (HR_{CORE})**			
	n	$\bar{X}$	SE	Range[a]	*n*	$\bar{X}$	SE	Range
Without Dogs (Tmt_1)	5	8	5	0.8-27.5	5	1.9	0.98	0.13-5.22
With Dogs (Tmt_2)	6	1.3	2.4	1.02-3.66	6	12.6	0.43	6.5-21.06
	t	df	SE	P >|t|[a]	*t*	df	SE	P >|t|
$Tmt_1 – Tmt_2$[b]	-0.89	9	5.2	0.40	-0.62	9	1	0.55

[a] Variables indicate number of bears in each treatment (*n*), mean home range and core area (*X*), standard error (SE), Range (min and max) of individual home ranges and core areas (km^2), t-value *(t)*, degrees of freedom (df), and P-value (P >|t|).
[b] Statistical difference between Treatments.

Home Range Comparison (Leigh vs. Wagner)

Home range (HR_{MCP}) size did not differ ($t_{df=11}$=0.21, SE=12.5, $P_{df=11}$=0.83) among male non-nuisance bears *(*χ=44.05 km^2*; n*=4*;* SE=10.7, Range=30.1 – 75.9*)* captured in 1994 (Wagner

1995) and male nuisance bears *(χ=41.39 km^2; n=9;* SE=6.8, Range=20.7 – 83.9*)* captured during my study.

Movements Following Treatment and Release

In all cases, bears conditioned with dogs moved greater distances following release than those conditioned without dogs, suggesting that bears may have been marginally influenced by the additional use of dogs. During the 24 hours following release, bears *(n=5)* conditioned without dogs moved a mean distance of 1197 m (CI_{Lower}= -14.8, CI_{Upper} =2409.4), whereas those conditioned with dogs moved 1855 m (CI_{Lower}= 896.3, CI_{Upper} =2813.4) from capture sites (Table 2).

Bears, on average, remained within 2 km^2 of capture sites 2 weeks following conditioning and release (Table 2). Bears conditioned without dogs moved a mean distance of 1172 m (CI_{Lower} = 3.4, CI_{Upper} = 2340.3) and those conditioned with dogs moved a mean distance of 2091 m (CI_{Lower} = 1019.7, CI_{Upper} = 3169.1) from capture sites 2 weeks following release (Figure 3).

A similar trend was revealed in the mean distance bears *(n=10)* moved until being observed displaying reoccurring nuisance behavior following release; bears conditioned with without dogs moved a mean distance of 1312 m (CI_{Lower} = -470.8, CI_{Upper} = 3094.2) and those conditioned with dogs moved a mean distance of 3463 m (CI_{Lower}= -7.3, CI_{Upper} = 6933.2) from capture sites (Table 2).

Table 2. Mean distance (m) bears moved from capture sites 24 hours and 2 weeks following release, in addition to mean distance (m) moved until observed displaying reoccurring nuisance behavior (RoN) and overall mean distance bears moved following release between treatments used to deter nuisance black bear activity in southern Louisiana, 2005-06.

	Distance Moved After 24 Hours				**Distance Moved After 2 Weeks**			
	n	$\bar{X}$	SE	CI[a]	*n*	$\bar{X}$	SE	CI
Without Dogs(Tmt_1)	5	1235	437	-14.8, 2409.4	5	1172	421	3.4, 2340.3
With Dogs (Tmt_2)	6	1940	373	896.3, 2813.4	6	2091	417	1019.7, 3163.1
$Tmt_1 – Tmt_2$[b]		-658	570	-1948, 633		-920	597	-2271, 431.6

	Distance Moved Until RoN				**Overall Distance Moved**			
	n	$\bar{X}$	SE	CI	*n*	$\bar{X}$	SE	CI
	5	1312	642	-470.8, 3094.2	5	1654	512	232.1, 3076.3
	5	3463	1250	-7.3, 6933.2	6	2941	788	913.9, 4967.4
		-2151	1405	-5391, 1089		-1286	987	-3518, 945.6

[a] Variables indicate number of bears in each treatment (*n*), mean distance bears moved from capture sites (*X*), standard error (SE), 95 % confidence interval (Lower and Upper) of individual movements (m).
[b] Difference between Treatments used (without dogs vs. with dogs).

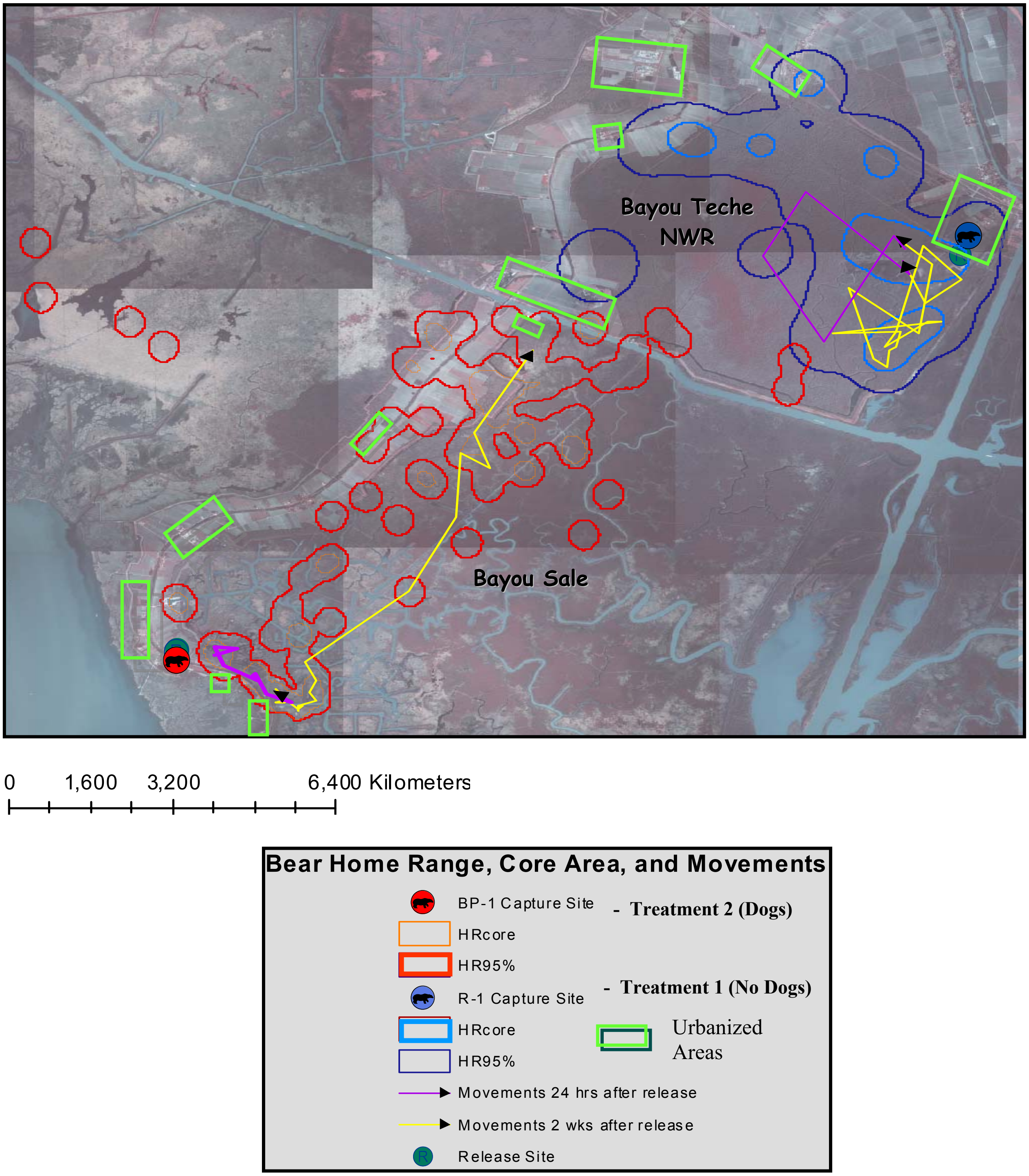


Figure 3. Nuisance bears conditioned with differing treatments (dogs vs. no dogs) and respective capture (Residential Area) and release sites, home ranges, core areas of use, and movements 24 hours and 2 weeks following conditioning and release in St. Mary Parish of southern Louisiana, 2005-06.

Ten bears (91%) returned to nuisance behavior within 5 months, regardless of treatment used (Table 3). Only 1 bear returned to its respective capture site, the remaining 9 bears displayed RoN behavior at new sites. Mean distance these bears moved from capture sites when exhibiting nuisance behavior at new sites was 3152 m (min= 38 m, max= 7122 m). Bears *(n=6)* that were reconditioned (rubber buckshot and loud noise) while observed displaying nuisance behavior moved a mean distance of 949m (min= 30 m, max= 4410 m) from new sites 24 hours following reconditioning. Only 1 of the 10 RoN bears was recaptured and reconditioned with Treatment_2 protocol; he moved a distance of 4732 m from the recapture site 24 hours following reconditioning and release, which was greater than the distance moved from the first capture site with a mean distance of 2288 m (min= 1653 m, max= 2764 m) 24 hours following conditioning and release. Bears exhibiting habitual nuisance behavior ($\geq$ 3 RoN events) were observed continuing nuisance activity $\leq$ 48 days after reconditioning with a mean distance of 148 m (min= 30 m, max= 519 m) between consecutive events.

Table 3. Time period (days) until reoccurrence of nuisance behavior (RoN) of Louisiana black bears (Ursus americanus luteolus) released following aversive conditioning treatments in southern Louisiana (St. Mary, Iberia, and Vermillion parishes) from April 2005 to June 2006.

Days until RoN	**Treatment_1 [a] (n = 5)**	**Treatment_2 [b] (n = 6)**
$\leq$ 5	2	1
6 – 15	1	2
103 – 144	2	2
$\geq$ 145		1 [c]

[a] Number of bears conditioned with rubber buckshot and loud noise.
[b] Number of bears conditioned with rubber buckshot, loud noise, and dogs.
[c] Bear never confirmed RoN during study.

One bear was observed continuing nuisance behavior twice in the same day at sites within 450 m of each other. Bears conditioned without dogs moved an overall mean distance of 1654 m (CI_{Lower}= 232.1, CI_{Upper} = 3076.3) and those conditioned with dogs moved an overall mean distance of 2941 m (CI_{Lower}= 913.9, CI_{Upper} = 4967.4) from capture sites (Table 2).

Anthropogenic Interaction

Of the 11 bears studied, 4 possessed home ranges that substantially overlapped ($\geq$ 97 %) urbanized areas, 5 had home ranges with moderate to high overlap (51% to 84%) with urbanized areas, and 2 bears had less than 50% of their home ranges overlapping or juxtaposed (within 1 km) to urbanized areas. There appeared to be a connection with anthropogenic percentage overlap and reoccurring nuisance behavior by bears captured during our study; bears with higher percentages of anthropogenic overlap were observed repeating nuisance behavior on numerous occasions throughout the study ($\geq$ 2 sightings), and bears with lower levels of overlap were observed displaying nuisance activity less often ($\leq$ 1 sightings). Bears with access to higher proportions of contiguous natural habitat relative to urbanized areas demonstrated lower percentages of anthropogenic interaction (Table 4 and Figure 3).

Space Use

Nine bears (82%) exhibited moderate to extensive home range overlap with 1 or more bears, and 7 bears (64%) had overlapping core areas with other neighboring bears captured during this study. Both females (W-1 and W-2) in our study exhibited the greatest percentage of home range overlap (99%) with a single male bear (I-3) that reciprocally overlapped their home ranges with 6 – 10% of his overall home range. Five male bears (56%) exhibited home range and core area overlap with other male bears (Figure 5 shows overlap of 3 male bears). Mean home range and core area overlap estimates for all bears are provided in Table 5.

Table 4. Percentage (%) of bear locations found within anthropogenic areas in southern Louisiana, 2005-06.

Bear ID	**Sex**	**% Urban Interaction**
BP-1	M	42
G-1	M	12
A-1	M	57
W-1	F	100
W-2	F	96
P-1	M	84
P-2	M	83
I-1	M	97
I-2	M	70
I-3	M	51
R-1	M	26

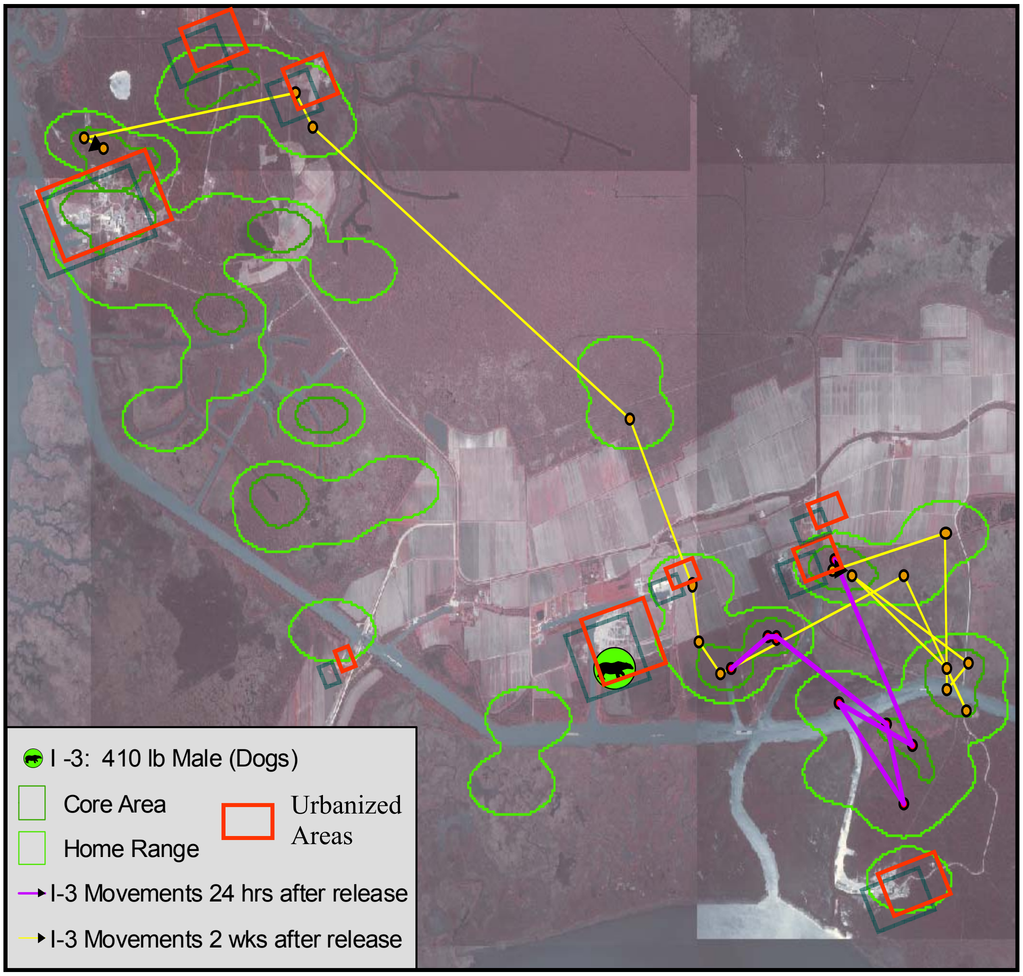


Figure 4. Nuisance bear (captured in industrial area) home range, core area of use, and movements 24 hours and 2 weeks following conditioning and release in St. Mary Parish of southern Louisiana, 2005-06.

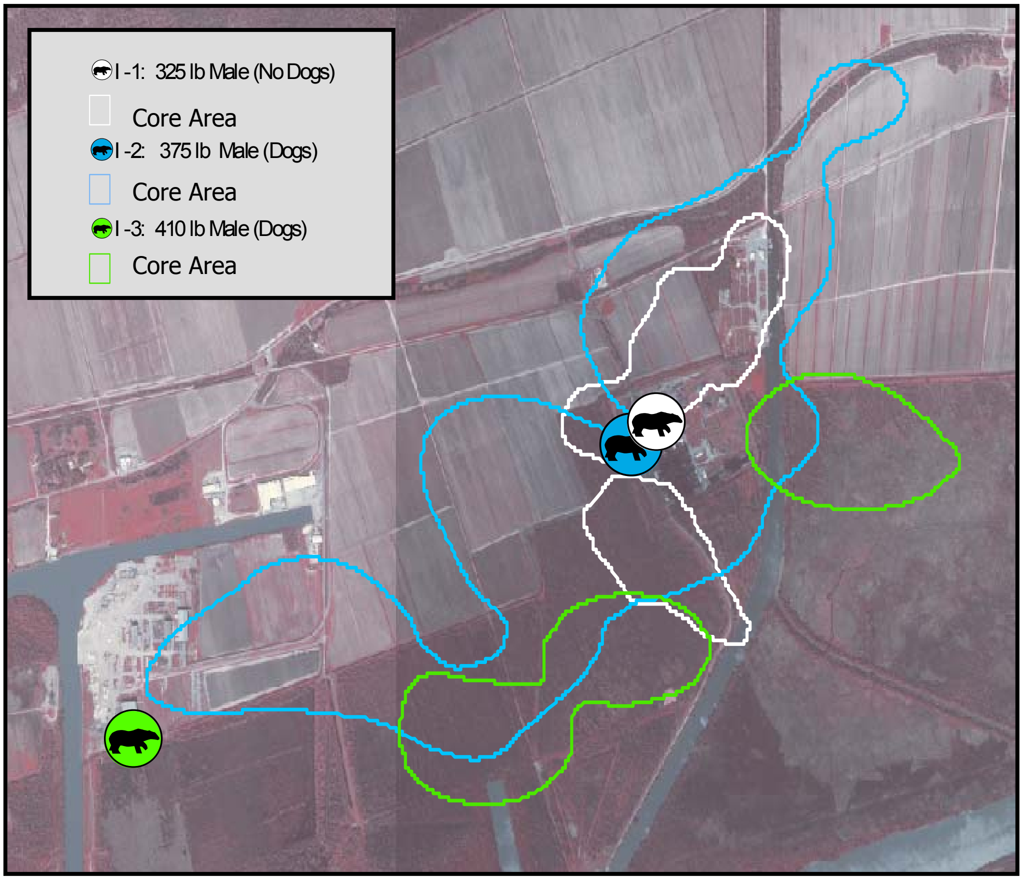


Figure 5. Overlapping core areas of 3 male bears captured in industrial areas in St. Mary Parish of southern Louisiana, 2005-06.

Table 5. Space use overlap (%) of home ranges and core areas of bears in southern Louisiana, 2005-06.

Bear ID	**Sex**	**Home Range**		**Core Area**	
		n	%	*n*	%
BP-1	M	1	1	0	0
W-1	F	2 (1**)	99	2 (1**)	57
W-2	F	2 (1**)	99	2 (1**)	42
P-1	M	1	16	1	2
P-2	M	2	10	2	3
I-1	M	3	83	1	39
I-2	M	2	50	2	20
I-3	M	4	41	3 (2**)	7
R-1	M	1	1	0	0

Variables represent: number of bears that exhibited home range overlap with specified individuals (*n*) and percentages that home range and/or core area overlap (%).
** indicates overlap with opposite sex.

DISCUSSION

Human-bear conflicts pose significant concern in urban-wildland interfaced communities throughout North America. Nuisance reports involving black bears have shown a steady increase in magnitude and frequency, with a rise of > 1500 cases reported in the last decade throughout eastern portions of the United States (Spiker 2007). Increasing human encroachment into historic black bear habitat has significantly contributed to the escalation of human-bear conflicts due to the loss of natural food items and the increasing presence of refuse generated by humans.

In Louisiana, the human population has increased by more than 54,652 since 2000. The Coastal ARB region, a prevalent source of human-bear conflict reports, has experienced an increase of > 2824 people (U.S. Census Bureau 2005). Black bear population estimates from previous mark-recapture research reported an abundance of 77 $\pm$ 9 bears in this region (Triant et al. 2004), revealing the disparity among human and bear populations that largely accounts for human-bear conflicts throughout southern Louisiana.

Many states have addressed human-bear conflicts by implementing non-lethal deterrent measures in addition to adjusting hunting season regulations (length of season, baiting, and bag limits). Louisiana is 1 of 8 states in the eastern U.S. that currently does not allow harvest of black bears; the season was closed in 1988 due to the decline in bear abundance and the subspecies was consequently listed as federally threatened in 1992. Since 2000, Louisiana has experienced a notable increase in human-bear conflicts. The Louisiana Department of Wildlife and Fisheries (LDWF) has received an annual average of 200 nuisance complaints, commanding increased intervention; however, without a hunting season in place state and federal agencies are strictly limited to non-lethal management practices (aversive conditioning techniques).

Various methods of aversive conditioning such as lithium chloride, loud noise, pepper spray, rubber buckshot, and dogs have been used on nuisance black bears by state and federal agencies across North America, but limited research has been conducted testing effectiveness of these methods in deterring nuisance black bear behavior (Colvin 1976, Gillin et al. 1994, Hunt 1984, Laycock 1987, Terbent and Garshelis 1999, Beckman et al. 2003 and 2004). Louisiana, much like other states, uses aversive conditioning techniques anecdotally, with limited knowledge of method efficacy on bear behavior following release and conditioning. This study attempted to address concerns relative to specific aversive conditioning methods (rubber buckshot, loud noise, and dogs) used by local state and federal agencies in Louisiana. I found that 91% (*n*=10) of bears returned to nuisance behavior, 60% (*n*=6) of which returned within 15 days following release and the remaining bears (*n*=4) returned within 144 days regardless of the combination of treatments used. Similarly, Beckman et al. (2004) reported a 92% (*n*=57) return of bears to nuisance behavior, with 70% (*n*=44) returning within 40 days following release regardless of treatment used. More over, they observed behavioral trends similar to my observations; bears treated with dogs remained away for slightly longer periods of time than those treated with other deterrent methods alone. In my study, this trend also was demonstrated in mean distance bears moved following conditioning for all periods examined between treatments (no dogs vs. dogs); bears treated with rubber buckshot in combination with dogs moved farther distances from capture sites and stayed away slightly longer than those treated with rubber buckshot alone (Figure 6).

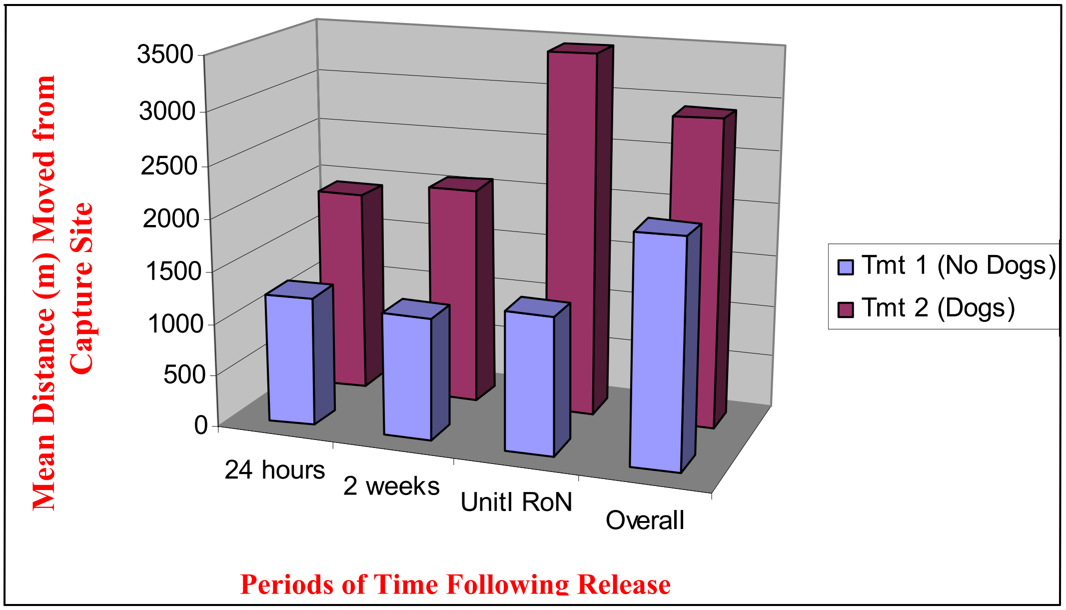


Figure 6. Mean distance (m) bears moved from capture sites among treatments (No Dogs vs. Dogs) during periods of 24 hours and 2 weeks, for periods until bears were observed displaying RoN behavior, and for the entire study following release in southern Louisiana, 2005-06.

While statistical tests were unable to detect a significant difference ($P<0.05$) between treatments used during this study (possibly due to small sample size), marginal differences were observed using 95% confidence intervals about the mean for distances bears moved between treatments. I chose to report results using 95% confidence intervals relative to estimated means to better indicate possible test significance and to provide a good estimate of effect size and a measure of its uncertainty; offering more information than do *P*-values presented alone (Johnson 1999).

Comparable patterns in home range and space use have been documented throughout existing black bear subpopulations in Louisiana (Wagner 1995, Marchinton 1995, Van Why 2003, Benson and Chamberlain 2007). Wagner (1995) reported mean home range (44.05 km^2) estimates for male non-nuisance coastal black bears that were similar to mean home range (41.39 km^2) estimates for male nuisance bears in my study, suggesting that habituated behavior may have limited influence on male space use. Female bears (*n*=2) in my study had very small mean home ranges (HR_{95}=0.86 km^2 and MCP=1.56 km^2) not typical of non-nuisance female bears. Wagner (1993) reported coastal female home range estimates (MCP= 15.3 km^2) far larger than our estimates. This difference could have been influenced by a number of factors in our study such as sample size, dropped collars, monitoring periods, and nuisance behavior. Small sample size (*n*=2) made it difficult to quantitatively compare home range size to previous research. Dropped collars greatly reduced monitoring duration; both females lost their collars (due to defective leather spacers) within 5 months following release. Longer monitoring periods could have provided more comprehensive results relative to female nuisance bear home range size. Nuisance behavior, though not related to male home range size in our study, may have influenced female home range size. Female home ranges and core areas overlapped urbanized areas by more than 96%. Armstrup and Beecham (1976) hypothesized that female ranges should be large enough to provide adequate resources for production and support of offspring. My results suggest that female black bears habituated to urbanized areas with a readily abundant food source may not need to maximize home range size if resources are centrally located.

Small sample size proved to be an important but unavoidable limitation in my study, as is typical of studies monitoring behavior of large carnivores. Although bears (*n*=11) captured during my study represented approximately 15% of the estimated coastal Louisiana subpopulation (Triant et al. 2004), larger sample size is needed to adequately detect the true effectiveness of deterrent methods used. Difficulty in attaining a larger sample size was largely attributed to problems associated with trapping and nuisance reporting. A large proportion of nuisance bear activity in residential areas was not reported due in part to confusion concerning the source; many residents consulted during our study did not actually see bears exhibiting nuisance activity. Although a toll-free hotline for reporting nuisance bear activity was provided by LDWF, many residents still had limited knowledge of how to report nuisance activity. I noted on numerous occasions that citizens were discouraged by not knowing whom to contact and dissatisfied with responses by local law enforcement and/or state and federal agencies responsible for nuisance bear management. The lack of on-site personnel dedicated to handling nuisance concerns in affected areas and a generally slow response (e.g. >5 days) to nuisance reports were contributing factors to these concerns. Black bear nuisance reports during this study were routed from administrative personnel (via a toll-free hotline) to personnel at LDWF in Baton Rouge (1 hour and 45 minutes from the coastal region). Upon receipt of complaints the person(s) reporting nuisance activity was contacted by LDWF for information about the incident and only complaints attributed to reoccurring nuisance activity resulted in on-site management. An effective solution, ensuring prompt on-site response to nuisance complaints, would entail dedicating trained and permitted personnel to areas reporting nuisance activity. While this practice may be an effective means in decreasing human-bear conflicts, it would require additional allocation of funds and resources to implement in affected areas; factors that should be considered when assessing future nuisance black bear management practices.

The degree of severity and frequency of nuisance bear activity also appeared to influence reporting of nuisance activity. In cases where nuisance activity was repeatedly reported, it was often observed to be a reoccurring nuisance bear already captured and treated. Hence, the lack of reports of nuisance activity, attributable to bears not already included in the study, contributed to our low sample size. The timeliness of reports also was imperative due to the brief window of opportunity (usually less than 1 week) existing to trap specific individuals in affected areas.

Areas with a high distribution of human refuse, most evident in densely populated residential areas, posed the greatest challenge in trapping nuisance bears during my study. The abundance of trashcans distributed throughout affected neighborhoods made it difficult to target and capture specific individuals. Highly habituated individuals previously captured and conditioned by state and federal agencies prior to this study proved to be difficult to recapture because of trap avoidance observed by citizens and myself, suggesting that bears retain knowledge of negative experiences associated with trapping methods (culvert traps).

My findings, similar to previous studies, suggest that deterrent methods currently adopted by many state and federal agencies have limited short-term effectiveness (Beckman et al 2004). A more interactive approach should be considered in the management of human-bear conflicts, placing greater emphasis on public education of nuisance bear behavior, and providing preventive instruction. Additionally, measures addressing food source should be aggressively pursued, such as implementing the widespread use of bear-proof trash containers in all affected areas and governing ordinances with stiff penalties against the intentional feeding of black bears. LDWF, in cooperation with the U.S. Fish and Wildlife Service (USFWS), passed a no feeding ordinance in 2002, and subsequently provided residents in affected areas of St. Mary Parish with bear-proof trashcans. LDWF has since reported a reduction in nuisance bear complaints, suggesting that this approach may have been a successful factor in reducing human-bear conflicts in south Louisiana. The USFWS and the Black Bear Conservation

Committee (BBCC) have played an active role in some affected communities, providing education to citizens to heighten bear awareness. The USFWS hosts an annual event called the Franklin Black Bear Festival, located in St. Mary Parish, to encourage the public to learn more about the Louisiana black bear through bear-related literature, presentations, and games. During my study, I promoted public education and cooperation by encouraging residents to participate in particular aspects of capturing and releasing bears. In addition to allowing the community to name bears captured, this also included on-site education on nuisance behavior and management techniques, placing emphasis on preventive measures that can be implemented to avoid conflicts with bears.

Tavss (2005) suggested that human-bear conflicts can be successfully addressed by using non-violent programs that include public education about bear propensity to eat garbage (placing great emphasis on never feeding bears intentionally or unintentionally), bear-proofing garbage containers, and enforcing ordinances regarding human refuse. U.S. national parks (Yellowstone, Yosemite, and Great Smoky) and communities bordering black bear habitat (Juneau [Alaska], Elliot Lake [Ontario, Canada], and the Lake Tahoe Basin [Nevada]) that use this program have reported fewer conflicts involving nuisance black bears. In all instances, the removal of food source has been successful in substantially reducing reported human-bear conflicts by 40 to 80% (Tavss 2005).

My results suggest that aversive conditioning methods have limited effectiveness in deterring nuisance bear activity when used independent of management practices addressing food source. Therefore, I recommend that agencies responsible for nuisance bear management use aversive conditioning techniques as a supplemental tool in support of programs that focus on addressing food source through public education and the use of bear-proof trash containers. The combination of these practices may improve the probability of successfully reducing human-bear conflicts in affected areas.

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VITA

Jennifer Leigh was born in Baton Rouge, Louisiana, on October 21st in the bicentennial year of 1976. As a child, she spent an enormous amount of time outdoors learning to hunt and fish from her brother, Mike, in the hills of Mississippi and on the coast of Louisiana. She graduated high school from Belaire Medical Magnet in Baton Rouge and joined the United States Air Force shortly thereafter, where she excelled as a Security Forces Member in Texas for a tour of duty before returning to her hometown to continue her education at Louisiana State University. In search of her niche, she volunteered and worked on numerous projects under the direction of Dr. Chamberlain. She became the first in her family to graduate from college, earning the degree of Bachelor of Science from Louisiana State University in December 2004. Upon graduation she was offered a graduate position at Louisiana State University working on nuisance black bear research with Dr. Chamberlain. Jennifer will be employed as a Wildlife Biologist by Soterra, LLC in Louisiana and will be awarded the degree of Master of Science during the summer commencement of 2007.