# MANAGEMENT STRATEGIES FOR ENDANGERED FLORIDA KEY DEER

A Thesis

by

MARKUS NILS PETERSON

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2003

Major Subject: Wildlife and Fisheries Sciences

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Approved as to style and content by:

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| Nova J. Silvy<br>(Co-Chair of Committee) | Roel R. Lopez<br>(Co-Chair of Committee) |
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# ABSTRACT

Management Strategies for Endangered Florida Key Deer.

(August 2003)

Markus Nils Peterson, B.S., Texas A&M University

Co-Chairs of Advisory Committee: Dr. Nova J. Silvy
Dr. Roel R. Lopez

Urban development is of particular concern in the management of endangered Key deer (*Odocoileous virginianus clavium*) because highway mortality is the greatest single cause of deer mortality (≈ 50%), and the rural community of Big Pine Key, Florida constitutes the majority of Key deer habitat. Study objectives were to provide and synthesize management strategies useful in the recovery of Key deer. Specifically, I (1) used simulation modeling to evaluate effects of fetal sex ratios (FSR) on Key deer population structure, (2) evaluated the most efficient and socially acceptable urban deer capture methods, (3) evaluated changes in fawn survival, mortality agents, and range size between 1968-2002, and (4) conducted an ethnography of the human population on Big Pine Key to ascertain cultural dynamics within the community and provide guidelines for community based management of Key deer.

Key deer were radio-collared ($n$ = 335) as part of 2 separate field studies (1968-1972, 1998-2002), and mortality and survey estimates were collected throughout the entire period (1966-2002). During 1990-2002, I used an ethnographic approach to

analyze the conflict surrounding Key deer management and explored how conflict and moral culture applied to this endangered species. These data were used to address my study objectives.

I found the most commonly cited FSR (2.67:1, male:female) for Florida Key deer to be inaccurate. A male biased FSR of 1.45:1 was more probable. Modified drop and drive nets were appropriate methods for urban deer capture because they are passive, silent, fast, generally accepted by the public, and yielded low mortality and injury rates. Between 1968-2002 Key deer fawn survival increased in tandem with human development while range sizes decreased. This suggests a positive, but not sustainable, relationship between fawn survival and development. I found disputants on Big Pine Key divided into 2 moral cultures, 1 grounded in stewardship and the other in private property rights. Successful management strategies for the Key deer require understanding and addressing issues at several levels including: Key deer demographics, community perspectives, and cultural norms. Collectively this information can be used by wildlife managers to improve the management and recovery of Key deer.

# DEDICATION

For Shannon

## ACKNOWLEDGMENTS

I thank the Big Pine Key, Florida community for sharing the insights they have gained through decades of wrestling with Key deer management. Without their generous assistance, this effort would have been impossible. I thank National Key Deer Refuge personnel for access to their press archive. In particular I thank Phil Frank for his candid evaluation of the conflict. I thank W. Becker, of WWUS radio, for giving me access to the only verbatim records of the public meetings associated with our research. Thanks to Brad Porter for his hard work and dedication as a student intern helping me conduct research. I also would like to thank my committee Roel Lopez, Nova Silvy, and Donald Davis for providing guidance and support throughout my tenure at Texas A&M University. I thank Roel Lopez and Nova Silvy in particular for being mentors and for helping me work through endless ideas, drafts, manuscripts, and applications. Thanks to Bill Grant and Jorge Zalles for inspiring many of those ideas with their insights. I thank Texas A&M University, the Texas Agricultural Experiment Station, and the National Key Deer Refuge for technical and financial support. I also thank the Department of Wildlife and Fisheries Sciences at Texas A&M University for its support, particularly Janice Crenshaw and Ann Williams for helping me graduate. Finally, I thank my family. Thank you, Mom and Dad, for giving me a love of wild things and wild places, a belief that they can be saved, and helping me to express it in writing. Special thanks to you, Shannon, for your infectious love of wildlife, your patience with my eccentricities, your encouragement, and your assistance with field work and writing.

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# CHAPTER I

# INTRODUCTION

## BACKGROUND

Traditionally, human development was considered the primary threat to Key deer recovery (Klimstra et al. 1974). Humans inhabit approximately half the islands in the deer's range, and 8 islands have large subdivisions and considerable commercial development (Folk 1991). During the 1980s, human population on Big Pine Key increased 77% (Monroe County Growth Management Division 1992). Folk (1991) hypothesized this increased development would lead to fewer deer. Current estimates for Big Pine and No Name keys, however, indicated that Key deer numbers increased by approximately 240% during this period (Lopez 2001).

The growth of the tourism industry, and a reliable supply of fresh water and electricity, contributed to dramatic human population growth in the Keys between 1950 and 1980. In 1975 the State of Florida declared the Keys an “Area of Critical State Concern” and Monroe County adopted a land-use plan and policy of preservation and reduced growth (Anonymous 2000). At the same time, both an improved highway and larger water pipeline were completed through the Keys, further stimulating growth. This counter-productive pattern of creating laws and policies, with attendant oversight agencies intended to slow human population growth, while at the same time catering to the desires of a massive influx of new residents, has continued unabated.

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This thesis follows the style of the Journal of Wildlife Management.

Recently, these 2 ultimately incompatible goals collided in Big Pine Key, where neighborhoods and even individual dwellings stand half built, epitomizing the conflict.

Although Key deer have been studied for nearly 30 years (Hardin 1974, Silvy 1975, Folk 1991, Lopez 2001), the currently accepted (Folk and Klimstra 1991*a*) fetal sex ratio (FSR) is questionable. Additionally, little is known about current fawn ecology. Intense community based conflict shadowed management decisions for the last 15 years, and any weakness in the science behind those decisions was brutally attacked. The refuge faced class action lawsuits, and attacks from civic groups and the local media. So, reliable and current data regarding fawn ecology and FSR is mandated scientifically, politically, and socially. Management decisions based on modeled population responses can only gain scientific and public legitimacy if the parameters are realistic.

Completing the picture of Key deer population ecology, through a fawn ecology and FSR study, will not eliminate management problems. An understanding of social and cultural dynamics also is essential for successful management. The Key Deer National Wildlife Refuge hired a private firm to conduct a public relations study (Anonymous 1997). Their suggestions mirrored those of an earlier United States Fish and Wildlife Service (USFWS) report on public relations (Faanes 1992). Neither of these studies addressed the social and cultural roots of the conflict within the community. Accordingly when refuge personnel attempted to follow guidelines from the reports they elicited a community backlash.

A systemic approach to Key deer management is needed to prevent such incidents in the future. At the Key deer population level, estimates of unknown parameters namely, FSR and fawn population ecology, are needed. At the community level, an understanding of public perceptions regarding research methods is needed, and at both national and local levels, an understanding of the cultural and moral norms within which management is evaluated also is needed. With such information, refuge research, publications, and public statements could be crafted to avoid the pitfalls associated with an ignorance of social and cultural norms.

**STUDY AREA**

The Florida Keys, within Monroe County, Florida, are environmentally and demographically unique. Tourism, retail services, commercial fishing, and government employ most of Monroe County's residents. This county has the highest cost of living and the fifth highest per capita income in Florida. They stretch southwest from the southeastern tip of the Florida mainland for >350 km. There are over 1,500 islands, but humans inhabit only 30. Among these is Big Pine Key, the largest of the lower Keys at 2,428 ha (Klimstra et al. 1974). Typically, island areas near sea level (maritime zones) are comprised of red mangrove (*Rhisophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erecta*) forests. With increasing elevation, maritime zones transition into hammock (e.g., Gumbo limbo [*Bursera simarub*], Jamaican dogwood [*Piscidia piscipulaa*]) and pineland (e.g., slash pine [*Pinus elliottii*], saw palmetto [*Serenoa repens*]) upland forests

intolerant of salt water (Dickson 1955). Approximately 24% of the native vegetation has been converted for residential or commercial uses since 1955 (Lopez 2001).

Big Pine Key is home to 4,206 humans (Anonymous 2000) and a formidable array of endangered or threatened species including the Key deer, silver rice rat (*Oryzomys palustris natator)*, Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), eastern indigo snake (*Drymarchon corais couperi*), Key tree-cactus (*Pilosocereus robinii*), and the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and loggerhead (*Caretta careeta*) sea turtles. At the local level, the Key deer has drawn more attention than any of the island's other species and inspired the most conflict. The USFWS listed it as endangered in 1967 (Folk 1991).

**OBJECTIVES**

1. Use simulation modeling to determine the most plausible FSR for Key deer.
2. Determine the most socially acceptable urban deer capture method.
3. Compare post-development (1998-2002) fawn survival and ranges to that of early-development fawns (1968-1972).
4. Conduct an ethnography of the human population on Big Pine Key to ascertain cultural dynamics within the community and provide guidelines for community based management of Key deer.

# CHAPTER II

# IMPLICATIONS OF FETAL SEX RATIO HYPOTHESES

## SYNOPSIS

Fetal sex ratios have important implications for managing small isolated populations. Mean male-biased FSRs ranging from 2.67:1 to 1:1 have been reported for the endangered Florida Key deer. Several general hypotheses have been proposed that describe the manner in which FSR may vary within a deer population over time: (1) tendency to equalize the sex ratio by producing the minority sex, (2) poor body condition results in more males, and (3) excellent body condition results in more males. My objective was to evaluate implications of FSR for Key deer as suggested by these hypotheses. Because of their small numbers and geographic isolation, the issue of FSR is important for predicting response of Key deer to management actions. I developed 9 alternative deterministic models representing combinations of 3 mean or median FSRs that have been hypothesized for Key deer and the 3 hypothesized mechanisms of FSR variation. With each model, I simulated Key deer demographics and compared predictions with actual survey data (1971-2000). The model with the best prediction was based on a median FSR of 1.45:1, and the FSR variation within the survey data best supported the hypothesis that poor body condition would result in more males. My results indicate the most commonly cited FSR (2.67:1) for Florida Key deer is inaccurate, probably due to small sample size. I conclude that FSR variation has the potential to shape the response of endangered populations to disturbance.

## INTRODUCTION

Fetal sex ratio is potentially an important demographic parameter. Models of large metapopulations often ignore FSRs because emigration and immigration can ameliorate potential changes in population sex structure as swings in sex ratio tend to even out over long periods of time, and density dependent influences on mortality and natality rates can exert a dominating influence on the population dynamics of a species. It also has been argued that population viability analysis models should only contain a level of detail consistent with the data available and should project population dynamics only over short time horizons (Akcakaya 2000). However, in small isolated populations, relatively small changes in FSRs can have a dramatic impact on population dynamics.

Although FSR allocation is poorly understood, some general hypotheses have been proposed. Fisher's (1930) sex ratio principle (FP) predicts a genetic tendency to produce offspring of the minority sex. Trivers and Willard (1973) proposed the maternal condition (MC) hypothesis for species with high maternal parental investment (PI) in which mothers in better condition would show a bias towards male offspring. Finally, according to the local resource competition (LRC) hypothesis, mothers should exhibit higher parental investment in the sex that competes least for limited resources (e.g., food, territory, and mating opportunities) among their offspring and between their offspring and themselves (Clark 1978, Silk 1983).

Confounding factors associated with work on large populations combined with the difficulty of interpreting PI with litters > 1 (Williams 1979) have made studying these hypotheses difficult in wild populations. Further, since differential mortality

between the sexes is rarely known, the argument that sex specific mortality might shape population sex structure (Clutton-Brock et al. 1985) rather than FSR allocation is irrefutable. The Florida Key deer provides a unique opportunity to analyze the demographic impact of different FSRs. Current (1998-2000) sex specific mortality and natality rates are similar to those previously (Silvy 1975) recorded (1968-1972) when the population was 1/3 its current density, according to radiotelemetry and mark-recapture data (Lopez 2001). Estimates of these population parameters also are available from necropsy data (1966–2000) (USFWS unpublished data). Folk and Klimstra (1991*a*) reported that the Key deer has relatively low potential growth rates due to low natality rates and a hypothesized male-biased FSR. Folk and Klimstra (1991*a*) observed a male-biased FSR with a mean of 2.67:1 in Key deer. Conversely, Lopez (2001) found a less extreme mean male-biased FSR of 1.45:1. Of course, accepting any skewed FSR would require rejecting the null hypothesis of random fluctuation around a mean FSR of 1:1.

Here, I describe development of a set of 9 simulation models representing the combinations of the 3 FSR variation hypotheses (FP, MC, LRC) and the 3 mean (or median) FSRs hypothesized for Key deer (1:1, 1.45:1, and 2.67:1). I then examine the sensitivity of each model to changes in age specific natality and mortality rates. Next, I identify those models capable of simulating the Key deer population trends and FSRs over the 1970-00 period. Finally, I explore the possibility of generating the historical Key deer population trends with urban development, disease, and/or mortality of deer due to auto collisions rather than variations in FSR.

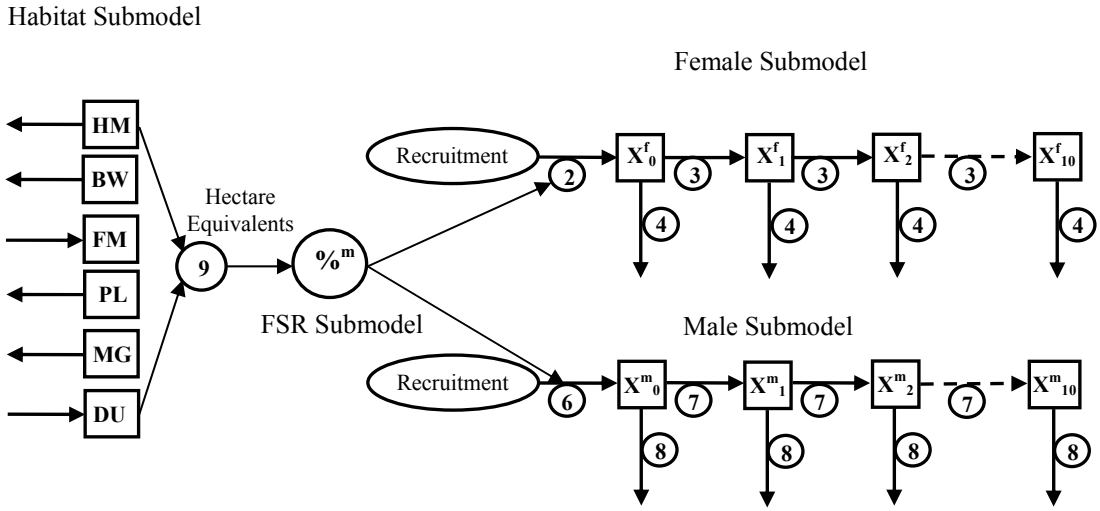


Fig. 2.1. Basic structure of the simulation models. $X^f_i$ and $X^m_i$ in the female and male submodels represent the number of females and males respectively, in the *i*th age class. The HM, BW, FM, PL, MG, and DU represent the number of hectares of hammock, buttonwood, freshwater marsh, pineland, mangrove, and developed upland, respectively. The $\%^m$ represents proportion male. Numbers inside circles represent equation numbers in the text.

## BASIC STRUCTURE OF THE MODELS

The basic structure of the 9 models is identical. Each model consists of 4 submodels representing (1) female demographics, (2) male demographics, (3) fetal sex ratio, and (4) habitat changes (Fig. 2.1). The female and male submodels simulate age specific mortality and, for females, natality rates. The habitat submodel represents increases or decreases in the number of "hectare equivalents" in each of 6 habitat types. A "hectare equivalent" is defined as the amount of land that has the same habitat value as 1 hectare of hammock habitat (the most preferred habitat of Key deer) (Lopez 2001). The proportion of land in each habitat type determines total hectare equivalents, which is an index of both quantity and quality of the habitat for Key deer (Lopez 2001). The FSR submodel determines FSR as a function of population density for MC and LRC variations or uses the mean FSR for FP variations.

## QUANTITATIVE DESCRIPTION OF THE MODELS

The models are represented mathematically as deterministic compartment models based on difference equations with a 1-year time step. Simulations were run on a personal computer using STELLA® II (High Performance Systems, Inc. 1994). All 9 models have identical female, male, and habitat submodels; they differ only in their FSR submodels.

### Female Submodel

This submodel contains 11 state variables representing the number of female Key deer in age class 0 (fawns), 1 (1 year old), …,10 (10 years old and older), and material transfer equations representing the processes of recruitment, survival (from one age class

to the next), and mortality. I present the general form of both state variable and material transfer equations below. In these equations state variables are denoted by upper case X's, rates of material transfers (recruitment, survivorship, mortality) by lower case letters, and model parameters (e.g., age-specific natality, mortality) by single lower case letters. Superscripts refer to sex of the animal and subscripts refer to age class of the animal at a specified time. State variable equations are of the general form:

$$X^{f}_{i,t+1} = X^{f}_{i,t} + (input_{i,t} - output_{i,t})\ \Delta t \quad (1)$$

Where $X^{f}_{i,t}$ is number of females in age class i at time t, $input_{i,t}$ is the sum of material transfers into $X^{f}_{i}$ during the time interval t to t+1 and represents natality or survivorship from the previous age class, and $output_{i,t}$ is the sum of material transfers out of $X^{f}_{i}$ during the time interval t to t+1 and represents mortality plus survivorship to the next age class. Material transfer equations are as follows:

$$f^{f}_{t} = \Sigma_i \alpha_i * X^{f}_{i,t} * (1 - \%^{m}) * ri_t \quad (2)$$

$$s^{f}_{i,t} = X^{f}_{i,t} - m^{f}_{i,t} \quad (3)$$

$$m^{f}_{i,t} = \gamma^{f}_{i} * X^{f}_{i,t} * mi_t \quad (4)$$

where $f^{f}_{t}$ is the number of female fawns born from time t to t+1, $\alpha_i$ is the number of fawns born from time t to t+1 per female aged i at time t, $\%^{m}$ is the % of fawns that are male, $ri_t$ represents a density dependent recruitment index ($ri_t = 1$ if population density (total number of $deer_t$ / total hectare $equivalents_t$) < 0.35; $ri_t = -5 * density_t + 2.75$ when population density ≥ 0.35), $s^{f}_{i,t}$ is number of females aged i surviving from time t to t+1, $m^{f}_{i,t}$ is number of females aged i at time t dying from time t to t+1, $\gamma^{f}_{i}$ is the proportion of females aged i dying from time t to t+1, and $mi_t$ represents a density dependent mortality

index ($mi_t$ = 1 if population density < 0.35; $mi_t$ = 5 * $density_t$ – 0.753 if population density ≥ 0.35).

Age specific survival rates for fawns, yearlings, and adults (Table 2.1), and natality rates for yearlings and adults (Table 2.1) are based on corroborating estimates from telemetry studies (1968-1972 and 1998-2000) (Silvy 1975, Lopez 2001). The initial, 1970, Key deer population level was 167 animals (Silvy 1975). Initial sex ratio was set at 1:1 and initial age structure reflected the age specific survival indicated in Table 2.1.

Table 2.1. Age and sex-specific survival and natality rates for Key deer ± standard deviations used in the simulation models (1998-2000, Lopez 2001). Mean values are used in the baseline versions of the models; standard deviations (SD) provide the ranges over which model parameters were varied during sensitivity analysis.

| | Female | | Male |
|---|---|---|---|
| Stage | Survival SD | Natality SD | Survival SD |
| Fawn | 0.615 ± 0.149 | 0 | 0.743 ± 0.110 |
| Yearling | 0.824 ± 0.071 | 1.050 ± 0.086 | 0.568 ± 0.089 |
| Adult | 0.842 ± 0.030 | 1.050 ± 0.086 | 0.597 ± 0.054 |

The mortality ($m^f_{i,t}$) and recruitment ($ri_t$) indexes have no effect until the population reaches 0.35 deer per hectare equivalent. In 1997, there were between 450-550 deer on Big Pine Key (0.22 deer per ha and 0.35 per ha equivalent) and natality and survivorship still were equivalent to all other years for which data are available (Lopez

2001). However, the density of 0.35 deer per ha equivalent does appear near the point where survivorship and natality are affected as evidenced by signs of malnutrition and disease (Lopez 2001). I assumed that natality rate decreases linearly and mortality rate increases linearly above this density. Because changes in age specific survivorship and natality were not detectable between the high and low populations in the range I attempted to simulate (Lopez 2001), density dependence was only included to prevent exponential growth in models not limited by FSR.

**Male Submodel**

This submodel contains 11 state variables representing the number of male Key deer in age class 0 (fawns), 1 (1 year old), …10 (10 years old and older), and material transfer equations representing the processes of recruitment, survival (from one age class to the next), and mortality. The equations are directly analogous to those described in the female submodel:

$$X^m_{i,t+1} = X^m_{i,t} + (input_{i,t} - output_{i,t})\ \Delta t \quad (5)$$

Where $X^m_{i,t}$ is number of males in age class i at time t, $input_{i,t}$ is the sum of material transfers into $X^m_i$ during the time interval t to t+1, and $output_{i,t}$ is the sum of material transfers out of $X^m_i$ during the time interval t to t+1. Material transfer equations are as follows:

$$f^m_t = \Sigma_i \alpha_I * X^f_{i,t} * \ \%^m * ri \quad (6)$$

$$s^m_{i,t} = X^m_{i,t} - m^m_{i,t} \quad (7)$$

$$m^m_{i,t} = \gamma^m_i * X^m_{i,t} * mi_t \quad (8)$$

where $f^m_t$ is the number of male fawns born from time t to t+1, $\alpha_i$ is the number of fawns born from time t to t+1 per female aged i at time t, $\%^m$ is the proportion of fawns that are male, $s^m_{i,t}$ is number of males aged i surviving from time t to t+1, $m^m_{i,t}$ is number of males aged i at time t dying from time t to t+1, and $\gamma^m_i$ is the proportion of males aged i dying from time t to t+1. Age specific survival rates for fawns, yearlings, and adults (Table 2.1) are based on corroborating estimates from telemetry studies (1968-1972 and 1998-2000) (Silvy 1975, Lopez 2001).

This submodel is parameterized differently for each of the 9 models with regard to (1) the mean FSR for the FP variation hypothesis, or the median FSR for the MC and LRC hypotheses and (2) the density dependent response of each FSR (Fig. 2.2). The mean FSR of those MC and LRC models predicting constantly high or low densities will not reflect the FSR being tested. By testing medians for these models I avoid the false assumption that mean FSR of model output resembles the FSR being tested. Thus median FSR, central to a hypothesized range, was tested for MC and LRC models.

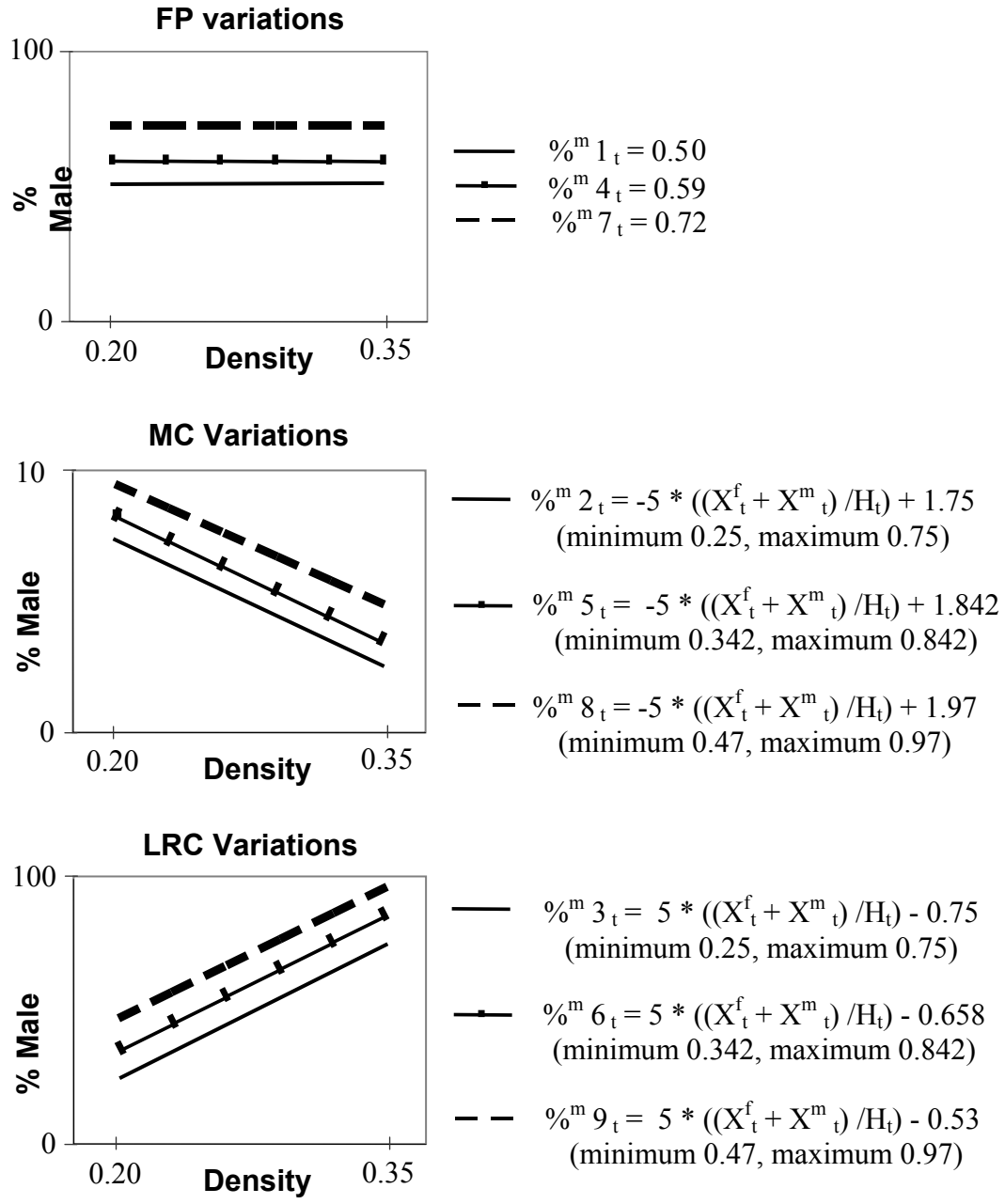


Fig. 2.2. Graphs representing the relationship between density and proportion male $\%^m$ for the 9 models simulating FSRs (fetal sex ratios). Relationships 1-3, 4-6, and 7-9 represent 1:1, 1.45:1, and 2.67:1 male biased FSRs, respectively. The FP, MC, and LRC refer to Fisher's principle, maternal condition hypothesis, and local resource competition hypothesis respectively. Where $H_t$ is the number of hectare equivalents at time t and $X^f_t$ and $X^m_t$ are the total numbers of female and male Key deer, respectively, at time t.

**Fetal Sex Ratio Submodel**

The density dependent response of the MC and LRC FSRs are calculated with linear equations bounded by +-50% of the median in the study population FSR (Fig. 2.2). There are no data with which to confirm or reject the hypothesis that the relationship between FSR and population density is linear, however, modification of the lines in Figure 2.2 such that they are convex or concave does not noticeably change the simulated population trends.

The potential range of variation in FSR is based on data from a pen study of white-tailed deer (Verme and Ozaga 1981). The $\%^m$ attains its minimum at a density of 0.35 for MC models and a density of 0.2 for LRC models, and attains its maximum at a density of 0.2 for MC models and a density of 0.35 for LRC models. This range of densities represents the highest and lowest known densities of Key deer observed (Lopez 2001). The density dependency of FSR is based on the assumption that maternal condition is inversely related to population density over the range of densities simulated by my models. Kidney fat indexes from Key deer necropsy data (USFWS unpublished data) support this assumption (Fig. 2.3).

**Habitat Submodel**

This submodel contains 6 driving variables representing the number of hectares in each of the 6 habitat types present on the study area. The relative value to Key deer of each habitat type was based on habitat use and availability data gathered from a telemetry study and is highest for hammock and lowest for mangrove (Lopez 2001). I assigned a "hectare equivalent" adjustment factor to each habitat type based on its value

relative to hammock. Hectare equivalent values for hammock (HM), buttonwood (BW), freshwater marsh (FM), pineland (PL), mangrove (MG), and developed upland (DU) are: 1, 0.341, 0.492, 0.884, 0.195, 0.492, respectively (Lopez 2001). Consequently the number of hectare equivalents at time t ($H_t$) is calculated as:

$H_t = BW_t*0.341 + FM_t*0.492 + PL_t*0.884 + HM_t*1 + MG_t*0.195 + DU_t*0.492.$ (9)

where $BW_t$, $FM_t$, $PL_t$, $HM_t$, $MG_t$, $DU_t$, represent the number of hectares in the indicated habitat type at time *t*. The initial hectares in each habitat type were: HM = 305.9, BW = 300.3, FM = 236.7, PL = 753.3, MG = 632.8 and DU = 329.1. The number of hectares lost per year (gained by DU and FM) is calculated as its total change in number of hectares over the last 30 years (HM = 81.88, BW = 34.33, FM = 2.29, PL = 166.62, MG = 37.15, DU= 281.45) times the proportion of the total number of hectares lost to urban development during the last 30 years that was lost during the given year (Table 2.2), where DU and FM are gaining and the other habitats are loosing hectares. The total hectares gained by FM and DU (283.7) does not equal the total hectares lost by other habitat types (320.0) because, footprints of buildings were excluded from DU (Lopez 2001). Freshwater marsh grew in area at the same rate as DU because, gain in FM was a function of gravel pit (used to provide fill for urban development) expansion.

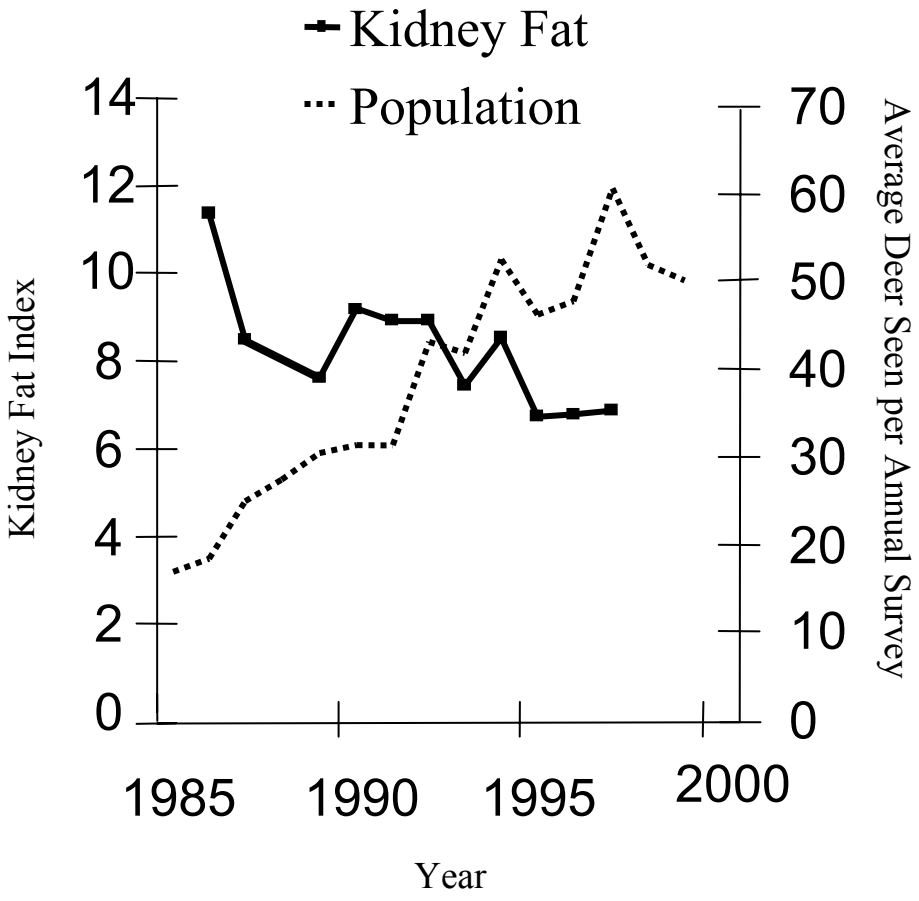


Fig. 2.3. Graph comparing Key deer population trend data to kidney fat indexes 1986-1997. (USFWS, unpublished data).

Table 2.2. Proportion of the total number of hectares lost to urban development over the last 30 years that was lost in the indicated year (Monroe County Property Appraiser, 2002 Tax Roll Database).

| Year | Proportion Lost |
|---|---|
| 1971 | 0.0211 |
| 1972 | 0.0336 |
| 1973 | 0.0336 |
| 1974 | 0.0316 |
| 1975 | 0.0307 |
| 1976 | 0.0336 |
| 1977 | 0.0230 |
| 1978 | 0.0403 |
| 1979 | 0.0561 |
| 1980 | 0.0374 |
| 1981 | 0.0417 |
| 1982 | 0.0244 |
| 1983 | 0.0402 |
| 1984 | 0.0508 |
| 1985 | 0.0714 |
| 1986 | 0.0642 |
| 1987 | 0.0657 |
| 1988 | 0.0633 |
| 1989 | 0.0599 |
| 1990 | 0.0412 |
| 1991 | 0.0259 |
| 1992 | 0.0244 |
| 1993 | 0.0230 |
| 1994 | 0.0211 |
| 1995 | 0.0216 |
| 1996 | 0.0081 |
| 1997 | 0.0063 |
| 1998 | 0.0053 |
| 1999 | 0.0005 |
| 2000 | 0.0000 |

## EVALUATION OF MODELS

### Sensitivity Analysis

Each of the 9 models was robust to changes in age specific natality and mortality rates. Altering them within the range of standard deviations indicated (Table 2.1) had little effect on Key deer population trends. Changing the density at which mortality rates begin to increase and natality rates begin to decrease, however, did influence results. As previously mentioned, when density dependent factors begin shaping the population they take the dominant role away from FSR. Thus, model 3 exhibited a growth curve similar to models 1 and 4 because it had the highest growth rate of the LRC models and density dependent changes in natality and mortality rates obscured the trend a LRC model typically predicts (Fig. 2.4). Lowering the threshold density required to increase mortality and decrease natality rates produces a trend similar to that seen in model 4 for models 6 and 9, respectively, as that threshold drops. Accordingly, raising the threshold would eventually produce a dampened oscillation in model 4.

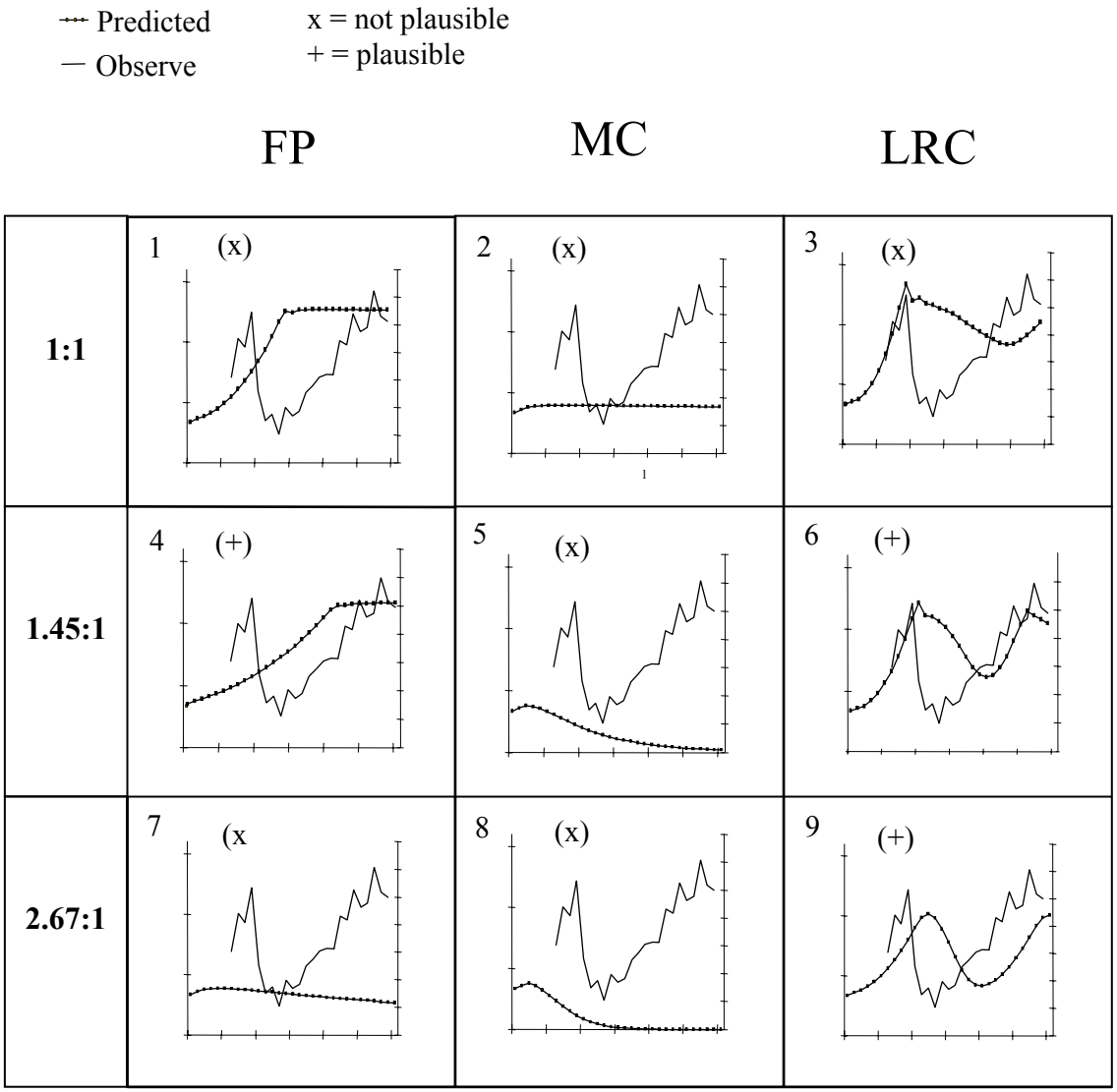


Fig. 2.4. Comparison of population trends predicted by each of 9 models (predicted deer numbers) to population trends observed by USFWS (average deer seen on annual census) from 1976-2000 (USFWS unpublished data). Numbers in the left margin of the figure refer to the mean fetal sex ratio. The FP, MC, and LRC refer to Fisher's principle, maternal condition, and local resource competition versions of FSR response to density respectively. Scale of y-axes in graphs were selected so maximum average deer seen approximated estimated carrying capacity.

**Comparing Alternative Models**

To evaluate the performance of my 9 models, I compared simulated population dynamics to observed population growth trends (USFWS, unpublished data) and the population change estimated between 1975 and 2000 (Lopez 2001). Due to the non-linear nature of population growth trends in the Key deer population (1976-2000) (Lopez 2001), results of model simulations were visually compared to observed growth trends. Models 2, 5, 7, and 8 were poor fits of the observed Key deer population growth trend data Model 6 appeared to give the best fit, but models 1, 3, 4 and 9 were plausible (Fig. 2.4). The 240% increase in the Key deer population between 1975 and 2000 supports elimination of models 2, 5, 7, and 8, since these models predict population decline (Fig. 2.4).

Comparison to actual FSRs is difficult due to gaps in data. However, necropsy data were taken for 13 years of the last 30 and the average male to female ratio of 1.45:1 (USFWS unpublished data) supports models 6 and 4 while contradicting models 1, 3, and 9. Ten of the 13 years of data were not included in the previous estimate of FSR (Folk and Klimstra 1991*a*), so the recent estimate is probably more appropriate for evaluating models. Yearly trends in FSR were inconclusive due in part to small sample size ($N$ = 6-11/year) and large gaps in the data.

The preference of model 6 over model 4 is supported by mortality data. Because mortality and recruitment rates have not changed dramatically over time (Silvy 1975, Lopez 2001), annual mortality should resemble total population size, as field data indicate (Fig. 2.5a). The oscillation indicated by mortality data supports the LRC

hypothesis in another less obvious way. Key deer males have higher mortality than females (Table 2.1) (Silvy 1975, Lopez 2001); so, a male bias in the population will lead to higher mortality than expected if the population had a 1:1 sex ratio and vice versa. My LRC model 6 correctly predicts lower mortality relative to population size after periods of low density and female-biased FSR (Fig. 2.5b, A), and higher mortality relative to population size after periods of high density and male-biased FSR (Fig. 2.5b, B).

Some propose the MC only applies at the individual level, and that population responses can be explained with higher newborn male mortality (Fisher 1930, Kojola 1997). Changing the male fawn mortality rate from 0.26 to 0.60, however, only made MC FSRs less plausible because it continues to reduce the already low-density population. This change had negligible effect on LRC FSRs. Further, the MC hypothesis depends on females biasing sex ratios of young based on their deviation from a female mean condition. This condition depends on forage, and with the exception of old, diseased, or otherwise weakened individuals, females will respond similarly to the fluctuations in forage resources.

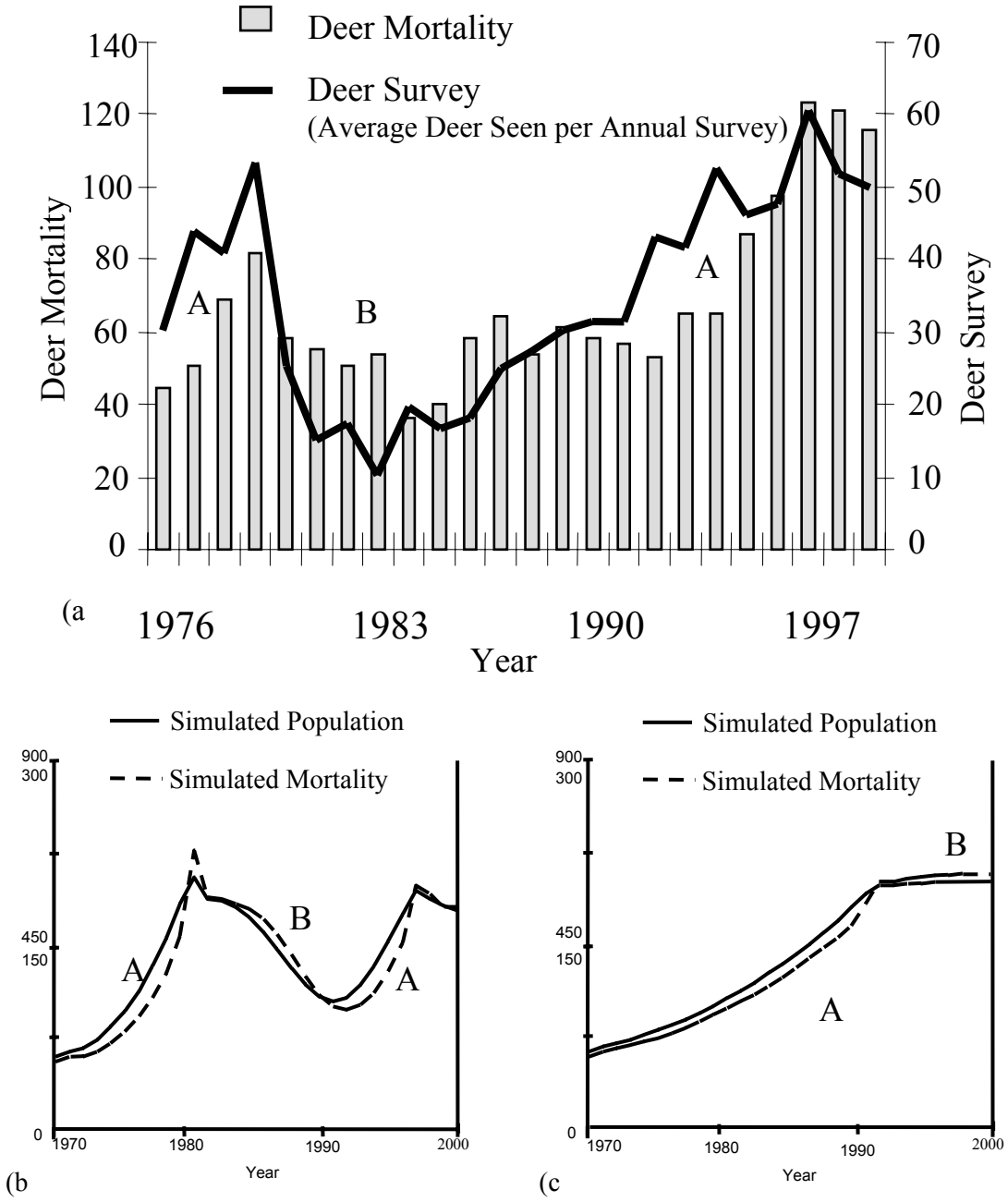


Fig. 2.5. Comparison of annual Key deer mortality numbers (1976-1999) and population trends: (a) observed trend and mortality (b) trend and mortality predicted by model 6, and (c) trend and mortality predicted by model 4. The A and B refer to areas of low mortality related to female bias in population and high mortality related to male bias in population, respectively. Scales of y-axes were adjusted to facilitate comparison of trends in the 2 curves.

## POSSIBLE ALTERNATIVE CAUSES

To avoid assuming a causal relationship between my best model and the observed trends in Key deer abundance I considered factors not involving FSR: development, disease, auto collisions, and density dependent changes in natality and mortality rates. I determined that human development itself was not a determining factor because when I doubled the recorded development rate, it did not produce a negative growth rate for the deer herd in models (1, 4) that had stable deer population growth rates under standard conditions. Since disease only accounted for 10% of Key deer mortality throughout the simulation period (Lopez 2001), it is unlikely that this parameter controlled the oscillations. Because auto-kill levels followed decreases in population rather than preceding them (Fig. 2.5a), auto-kill appears dependent on population size rather than vice versa. Finally density dependent changes in natality and mortality were also unlikely to direct population swings because, as previously noted, these parameters were similar in a period of population growth (1970–1975) and a period of stability or potential decline (1997–2000) (Lopez 2001).

## DISCUSSION

The model based on the previously accepted male-biased FSR with a mean of 2.67:1 (Folk and Klimstra 1991*a*, Hardin et al. 1984) does not reflect the population increase observed in the last 30 years (Fig. 2.4, model 7). Folk and Klimstra (1991*a*) suggested the LRC hypothesis was influential in producing the skewed FSR, however, the reported FSR of 2.67:1 was a mean of previous years. The LRC version of a median FSR of 2.67:1 only produced a population increase because its mean FSR was 1.8:1

(Fig. 2.4, model 9). Thus, the previously accepted view of FSR in Key deer cannot be reconciled with observed population growth rates.

Model 6 (a LRC model) best represented the FSR allocation in Key deer. This result has several important implications. First, it supports the view that FSR works according to the LRC hypothesis in Key deer. This in turn supports the hypothesis that deer can control herd size in the face of fluctuating and patchy food sources (Peterle 1975) because at low densities more females are produced, leading to higher population growth rates and at high densities more males are produced which leads to a decrease in population growth rate. Planned translocation of Key deer to uninhabited islands in the immediate future may provide an opportunity for field research to test the FSR hypothesis represented by model 6. Further, the isolated nature of the Key deer population could have given more weight to evolutionary pressures favoring LRC FSR allocation. This should not be misconstrued as "self regulation" because density indirectly controls FSR through female body condition. The decrease in recruitment resulting from male-biased FSR at high densities may influence population response to density to a greater degree than decreased natality or increased mortality. Small population size and low potential growth rates give FSR allocation more influence over Key deer population dynamics relative to other density dependent factors. In fact, Lopez (2001) demonstrated that the population stabilized after a 240% increase without significantly altering mortality and natality rates from 1970s levels (Silvy 1975).

The influential role of FSR in Key deer population dynamics has important management implications. The main management objective for Key deer is preventing

extinction. Catastrophic events such as a category 4 hurricane or disease epidemic are the only serious threats to population viability (Lopez 2001). Both the small population left after such a cataclysm and small populations created through relocation efforts should respond with dampened oscillations as predicted by model 6. These dynamics exist because when the population is above its equilibrium density, where the LRC hypothesis predicts a male-biased FSR, males are loaded into the population resulting in progressively lower per capita reproductive rates for the population. Because Key deer are relatively long-lived there is a time lag before the sex ratio of the entire population equalizes to a point where positive growth rates occur again.

Model 6 has important implications for USFWS public relations. It suggests the population will stabilize at levels higher than those observed in the 1980s, but that an epidemic disease or other disturbance could set off another series of dampened oscillations. The proponents of preservation and refuge expansion, who argue the population is currently on the top of a recurring oscillation and that management should be based on the next projected low (Peterson et al. 2002), would be correct in some cases. The concern for managing for projected lows would be important after large disturbances. However, oscillations should become progressively smaller and less important. Proponents of private property rights, who argue that the population is stable at its current high levels (Peterson et al. 2002), also would be correct. Future oscillations should be relatively small and insignificant. Basing management strategies on this view would be safe until a large disturbance lowers the population below its

equilibrium level. Armed with an understanding of model 6 and its implications USFWS could take a "you are both right" approach.

Understanding the mechanisms of FSR control provides other management opportunities. For Key deer, timing of fertilization within estrous may control FSR. Werren and Charnov (1978) found that a delay in mating during the estrous period caused an increase in the proportion of male progeny in many organisms. Verme and Ozoga (1981) found in white-tailed deer, early matings (13–24 hours) in the estrous period resulted in 14% males in the fawn crop ($N = 28$) whereas matings consummated late (49–95 hours) in the estrous period produced 81% males in the fawn crop ($N = 26$). Guerrero (1975) suggested that changes in vaginal and intra-cervical pH that occur around the time of ovulation differentially affect the motility of X- and Y-bearing spermatozoa and are able to influence the FSR. Harlap (1979) suggested the FSR variations were influenced by differential resistance of either sex to problems during embryonic development (e.g., chromosomal abnormalities, blastocystic death, blighted ova) linked to fertilization of older ova or by older sperm.

Little consensus exists regarding FSR allocation in animals, and its influence is usually ignored in managing and simulating wildlife populations. In most cases this approach is not problematic because other population parameters confound the influence of FSR and or approximate it. However, in some cases like that of the Key deer, FSR may exert a dominant influence over population dynamics. Other endangered (isolated) animal populations that exhibit LRC FSRs may react to disturbance like the Key deer. *K*-selected species in particular will respond in a similar manner. Oscillations in a more

*r*-selected population will have high frequencies that make monitoring and response more difficult.

Small population size, isolation, and low reproductive rates will magnify the influence FSR maintains in the population. Accordingly, many endangered animal populations cannot be accurately simulated without consideration of FSR allocation. Population viability analyses should consider all feasible scenarios (Beissinger and Westphal 1998), and FSR variation having a controlling influence on population dynamics is feasible. Regardless of the FSR mechanism in operation for a particular species (FP, MC, or LRC) influencing the breeding population to produce an excess of the sex limiting reproduction can accelerate captive breeding. Further, the management implications and strategy suggested by simulations under assumptions of different FSR allocation mechanisms will be extremely different (Fig. 2.4). Fetal sex ratio and the mechanism of allocation should be considered when managing endangered animal populations.

# CHAPTER III

# CAPTURE METHODS FOR URBAN WHITE-TAILED DEER

## SYNOPSIS

Wildlife management involving public participation is becoming commonplace. Given that successful management of natural resources increasingly depends on securing public cooperation, wildlife capture methods deemed unethical by the public should be avoided if possible. When evaluating the ethical use of wildlife capture techniques, the public sees animals as individuals while the wildlife profession focuses on populations and communities. Problems may arise when these differing perceptions of wildlife dictate different capture techniques. Urban white-tailed deer capture on private lands both typifies and magnifies the dissonance between wildlife managers and the public rooted in their different constructs of nature. I analyzed capture techniques from a (1) literature review of white-tailed deer capture and from (2) our own experiences working with the endangered Key deer to determine the most suitable methods for minimizing problems associated with the differing social constructions of wildlife. Many historical studies used drugs to immobilize, tranquilize, or sedate deer after physical capture and were characterized by high (>5%) mortality. Some studies also focused on demonstrating statistical differences in mortality between capture methods rather than decreasing mortality. Drop nets, drive nets, hand capture, net guns, dart guns, and box traps all were used by some researchers with mortality approaching 0. Modified drop and drive nets are appropriate methods for urban deer capture because they are passive, silent, fast, not associated by the public with weapons, and yield low mortality and

injury rates. Urban wildlife capture techniques with these attributes demonstrate respect for the public's individualistic view of wildlife and can be combined with education to generate support for research and management in urban areas.

**INTRODUCTION**

An emerging trend toward public participation in wildlife management has led to advocacy of public participation in many forms, including co-management (Chase et al. 2000) and community-based conservation (Western and Wright 1994, Wondolleck and Yaffee 2000, Brick et al. 2001). Securing the cooperation of diverse groups of people is essential to wildlife management (Peterson et al. 2002). Indeed, Riley et al. (2002:591) claimed that stakeholder participation is 1 of 2 key precepts that capture "the essence of wildlife management". Stakeholder involvement is, however, more than a trendy idea purporting to pacify interest groups through collaboration, consensus building, and ownership of the process. Urban sprawl, suburban development, and increasing incidences of controversy involving urban wildlife render public participation a condition inherent to wildlife management (Decker and Gavin 1987, Conover et al. 1995). Riley et al. (2002:586) argued this would require the wildlife profession to "reexamine its purpose to emphasize fundamental anthropocentric objectives". If this is a call to reexamine techniques, management goals, and policy in light of stakeholder perspectives, rather than a challenge to non-human centered ethics, I concur. Urban wildlife management will lead this movement by necessity if for no other reason. The ongoing transition toward public participation in wildlife management will likely require a reevaluation of the ethical basis for research within the wildlife profession as well as

how research is perceived by various publics. If this reevaluation is not self-imposed, various watchdog groups or community activists will impose it externally as they become more intimately involved in the management process (Farnsworth and Rosovsky 1993).

The public and the wildlife management profession tend toward fundamentally different perceptions of wildlife. Traditional wildlife management is rooted in Leopold's (1949:201–226) Land Ethic, and finds value in biological integrity (Callicott 1980). Accordingly, Leopold had, and many in the wildlife profession still have, no qualms about hunting, eating meat, or inadvertently killing animals while capturing wildlife. From a population or community perspective, the value of information garnered from research involving collection of animals or capture-related mortality outweighs the individual animal costs (Farnsworth and Rosovsky 1993). Further, the likelihood that these activities improve our ability to protect and/or restore ecological integrity makes them morally right according to the land ethic (Callicott 1980) and/or scientific construction of nature (Rolston 1981). Although the wildlife profession is by no means monolithic in this perspective, an emphasis on biotic populations and communities undoubtedly exists.

The public takes a more Kantian (Kant 1873) approach to wildlife management issues, where moral obligations are inherent within individuals. Kant suggested that cruel treatment of individual animals was wrong primarily because it evoked depravity in the abuser. Schweitzer (1950) placed individual animals on even stronger ethical footing by arguing for an equal reverence for life, whether human or non-human. Most

members of the public support animal welfare and compassionate treatment of animals for these reasons, but a significant portion also support animal rights. Singer's (1975) book, *Animal Liberation*, provided a philosophical rationale for extending rights from individual humans to individual animals (Muth and Jamison 2000). The contemporary animal rights movement is an attempt to broaden the list of species whose individual members are due moral consideration to some arbitrary point of sentience (Regan and Singer 1976, Singer 1975). Clearly, both animal welfare and animal rights advocates are more likely to focus on individual animals and their plight than an entire biotic community. Although the logic of perceiving wildlife in this fashion is questionable (Callicott 1980, 1987), it is psychologically appealing (Rolston 1981, Kellert 1986).

Neither the individualistic nor the population/community construct of wildlife is logically better, so both are legitimate viewpoints. Research involving urban wildlife in general, and urban endangered species in particular, compounds problems caused by these different social constructions of wildlife. Visibility, charisma, ubiquity in urban environments, and a relatively high ranking on a sentience scale make the white-tailed deer an excellent test-case regarding how wildlife professionals approach urban wildlife capture in the age of public participation (McAninch 1995, Messmer 1997, Chase 2000). These issues are further magnified when the management of an urban and endangered species, such as the Florida Key deer, is considered (Peterson et al. 2002).

Key deer management provides an ideal case study for evaluating capture methods for urban deer according to the aforementioned social constructions of wildlife. In this paper, I evaluate capture methods for urban deer using both published accounts of

white-tailed deer capture and personal experiences with capturing Key deer. I use capture-related mortality as an evaluative factor, because from an individualistic viewpoint, killing an individual is the ultimate wrong in wildlife capture. Individualists may quibble over how much discomfort capture must cause an animal before it is wrong, but killing the animal during capture is wrong by definition. I include personnel observations of deer capture on Big Pine Key, Florida, because a myriad of factors including perceived stress to the animal, time taken by the capture event, passivity of capture device, public education, researcher behavior, and the nature of the workup process influence public perceptions. Efficiency, in terms of worker-hours, becomes less important in urban environments where individual animals are endowed by much of the public with rights. Thus, trading deer lives for lower labor costs is morally repugnant to those with an individualistic viewpoint. Grossly inefficient capture methods purporting to cause low capture mortality still may be rejected, but are rare precisely because of the population-community perspective heretofore in vogue.

Thus, I evaluated a coterie of reasonably efficient capture methods for use in urban environments. More specifically, I (1) used field notes (1998–2002) to determine how residents, whose willing participation determined research success, viewed Key deer and capture methods, (2) compared capture mortality among different methods used to capture white-tailed deer in both urban and less human-influenced settings based on our experience with Key deer capture and published accounts, and (3) suggested methods for urban deer capture based on their respective mortality rates and public perceptions of urban wildlife.

## METHODS

### Key Deer Capture

Key deer were captured and fitted with mortality-sensitive radio collars (150–152 MHz, 100–110 g for plastic neck collars, 10–20 g for antler transmitters and elastic collars, Advanced Telemetry Systems, Isanti, Minnesota, USA) as part of other studies conducted January 1998–December 2000 (Lopez 2001, Lopez et al. 2003), and May–August 2002.

We captured deer using portable drive nets (Silvy et al. 1975), freestanding tension release drop nets (Lopez et al. 1998), hand capture (Silvy 1975), net gun (DelGiudice 2001), and dart gun. No more than 3 deer were captured at once using drop or drive nets. During net gun captures, deer were approached on foot rather than by helicopter. We captured adult deer using immobilizing drugs delivered with a Dan-inject® dart gun (Wildlife Pharmaceuticals, Fort Collins, Colorado, USA) with shots at ranges of ≤15 m to the gluteal muscle. Deer were immobilized with a combination of ≈ 5.1 mg ketamine hydrochloride and 1.1 mg xylazine hydrochloride per kg body mass via intramuscular injection. Deer captured using this procedure were held 24 hours at the National Key Deer Refuge (NKDR) deer facility to allow the drugs to dissipate before release.

With the exception of darted deer, physical restraint was used to hold all animals after capture for 5–15 minutes. Deer were blindfolded and physically restrained with rope to minimize struggling. Deer were handled on a stretcher and for each deer

captured, we recorded sex, age, capture location, weight, radio frequency, injuries sustained during capture, and body condition prior to release.

Radio-collared deer were monitored 6–7 times per week at random intervals via either homing or triangulation (Lopez et al. 2003). Mortality signals were immediately followed by walk-ins to determine cause of death from evidence at recovery sites. All carcasses were necropsied using procedures described by Nettles (1981), or submitted for necropsy to the Southeastern Cooperative Wildlife Disease Study, University of Georgia-Athens. Since clinical signs of exertional myopathy progress within a few days of capture, and rarely take as long as a month to appear (Basson and Hofmeyr 1973, Williams and Thorne 1996), we evaluated all mortalities occurring within 2 weeks of release for capture-related causes. All deer were monitored until radio failure.

During capture activities, both the method and purpose of the capture was explained to bystanders. We often demonstrated how telemetry equipment could locate the recently captured deer after it was released. Those who insisted on participating by encroaching on the handling area were enlisted to watch for vehicle traffic that might endanger the deer upon release. We also attended meetings of local organizations to inform the public about the study.

We used field notes taken during capture activities (1998–2002) to determine how the public viewed Key deer. Our notes reflected the perspectives of landowners living near/on suitable habitat patches who we asked for access, and spectators who offered their opinions without solicitation. I used the 5 steps of thematic analysis (Peterson et al. 1994): (1) searching for themes in each transcript, (2) developing each

theme, (3) determining the significance of each theme, (4) searching for oppositions among themes and thematic hierarchies, and (5) comparing thematic hierarchies and themes to analyze field notes.

**Retrospective Analysis**

I reviewed published literature on the capture of both urban and other white-tailed deer using the ISI Science Citation Index Expanded (1966–2002), and paper indexes for The Journal of Wildlife Management and the Wildlife Society Bulletin. I also evaluated additional studies cited in articles found using the aforementioned approaches. Studies with <10 deer captures per method were omitted. I noted capture method, number of deer captured, mortality observed, presence or absence of post-capture monitoring, whether tranquilizers, sedatives, or chemical immobilizing agents were used post-capture, and any unusual handling or transporting methods. I summarized trapping data and evaluated each method by capture-related mortality. Because differences in handling procedures, different post-capture monitoring periods (or lack thereof), and the common practice of sedating deer caught using nets or box traps could confound statistical tests, I compared capture methods using box-and-whisker plots.

Table 3.1. Summary of capture methods used for white-tailed deer, 1954–2002.

| Category<br>Capture method | Number captured | Mortality (%) | Post-capture monitoring | Chemical immobilization[a] | Reference |
|---|---|---|---|---|---|
| Passive, staffed | | | | | |
| Hand Capture | 40 | 0.0 | Yes | No | This study |
| Drive Net | 144 | 2.1 | Yes | No | Silvy et al. 1975 |
| Drive Net | 28 | 3.6 | No | No | DeYoung 1988 |
| Drive Net | 430 | 1.4 | Yes | No | Sullivan et al. 1991 |
| Drive Net | 69 | 0.0 | Yes | No | This study |
| Drop Net | 292 | 0.3 | No | No | Ramsey 1968 |
| Drop Net | 175 | 6.9 | Yes | 0.5 mg/kg xylazine | Conner et al. 1987 |
| Drop Net | 164 | 0.0 | Yes | No | This study |
| Passive, unstaffed | | | | | |
| Box Trap (Stephenson) | 47 | 0.0 | No | No[b] | Hawkins et al. 1967 |
| Box Trap (Cohick) | 92 | 7.6 | Yes | No | Peery 1968 |
| Box Trap (Stephenson) | 2,035 | 2.1 | No | No | Palmer et al. 1980 |
| Box Trap (Stephenson) | 367 | 3.3 | Yes | 1 mg/kg ketamine<br>1 mg/kg xylazine | Haulton et al. 2001 |
| Clover Trap | 115 | 0.9 | No | No | Clover 1954 |
| Clover Trap | 254 | 4.7 | Yes | No | Fuller 1990 |
| Clover Trap | 115 | 5.2 | Yes | No | Beringer et al. 1996 |
| Clover Trap | 167 | 7.2 | Yes | 300-400 mg ketamine[c]<br>50 mg xylazine | DelGiudice 2001 |

Table 3.1. Continued.

| Category<br>Capture method | Number captured | Mortality (%) | Post-capture monitoring | Chemical immobilization[a] | Reference |
|---|---|---|---|---|---|
| Clover Trap | 29 | 20.7 | Yes | 1 mg/kg ketamine<br>1 mg/kg xylazine | Haulton et al. 2001 |
| Corral Trap | 302 | 13.9 | No | No[d] | Hawkins et al. 1967 |
| Explosives mandatory | | | | | |
| Rocket/Cannon Net | 33 | 6.1[e] | No | No | Hawkins et al. 1968 |
| Rocket/Cannon Net | 17 | 23.5 | No | 50-100 mg promazine | Palmer et al. 1980 |
| Rocket/Cannon Net | 300 | 10.3 | Yes | No | Beringer et al. 1996 |
| Rocket/Cannon Net | 132 | 4.6 | Yes | 1 mg/kg ketamine<br>1 mg/kg xylazine | Haulton et al. 2001 |
| Net Gun | 42 | 2.4 | No | No | DeYoung 1988 |
| Net Gun | 63 | 1.6[f] | Yes | 300-400 mg ketamine[c]<br>50 mg xylazine | DelGiudice 2001 |
| Net Gun | 2 | 0 | Yes | No | This study |
| Chemical immobilization | | | | | |
| Crossbow | 83 | 15.7 | No | nicotine alkaloids | Hawkins et al. 1967 |
| Dart Gun | 75 | 20.0 | No | nicotine alkaloids | Hawkins et al. 1967 |
| Dart Gun | 44 | 13.6 | No | ≈ 9 mg succinylcholine chloride | Palmer et al. 1980 |
| Dart Gun | 23 | 0.0 | Yes | 200 mg ketamine[g]<br>70 mg xylazine | DeNicola and Swihart 1997 |

Table 3.1. Continued.

| Category<br>Capture method | Number captured | Mortality (%) | Post-capture monitoring | Chemical immobilization[a] | Reference |
|---|---|---|---|---|---|
| Dart Gun | 31 | 0.0 | Yes | 280 mg ketamine<br>225 mg xylazine | Kilpatrick et al. 1997 |
| Dart Gun | 51 | 2.0 | Yes | ≈ 13.3 mg/kg ketamine<br>≈ 2.7 mg/kg xylazine | Haulton et al. 2001 |
| Dart Gun | 7 | 0.0 | Yes | ≈ 5.5 mg/kg ketamine<br>≈ 1.1 mg/kg xylazine | This study |
| Longbow | 63 | 33.3 | No | nicotine alkaloids | Hawkins et al. 1967 |
| Oral Sedative | 36 | 22.2 | No | valium | Hawkins et al. 1967 |

[a] This category includes neuromuscular blocking drugs, general anesthetics, and/or tranquilizers/sedatives used after capture with non-chemical techniques.

[b] Used nicotine alkaloid injection on 1 adult male.

[c] Used 50 mg xylazine and 200 mg ketamine for fawns.

[d] Used nicotine alkaloid injections on adult males with 26.8% mortality.

[e] Both deer held >1.5 hours before release.

[f] This doe found tangled in a barbed wire fence.

[g] Used 35 mg xylazine and 100 mg ketamine for deer weighing < 45 kg.

## RESULTS

### Key Deer

*Capture, Mortality, and Injury.*—We captured 282 Key deer (128 males, 154 females) in our study using 5 techniques (Table 3.1). Mean shoulder height of adult Key deer was 71 cm (95% CI; 61–81 cm), and mean body mass was 29 (maximum 45 kg) and 38 kg (maximum 66 kg) for females and males, respectively. We observed no mortalities during capture activities, but 1 adult female caught with a drop net died 2 weeks post-capture when struck by a motor vehicle. Necropsy results did not suggest any capture-related problems. No serious injuries (e.g., lacerations, broken bones) were noted during capture activities. Two adult females limped and 1 female fawn had an abrasion on its tail after capture with the drop net. Two male fawns captured with a drive net and 1 hand-captured female fawn suffered minor abrasions.

*Public Perception.*—Analysis of field notes yielded 2 dominant themes regarding public perception of Key deer, and thus Key deer capture. The public demonstrated an individualistic and occasionally anthropomorphic—ascribing human characteristics to non-human entities—view of Key deer. The individualistic perspective toward deer was demonstrated by the "underground" medical care of deer. The "deer lady" was a somewhat mythical figure, possibly derived from multiple people, who dispensed medical advice to locals attempting to rehabilitate injured deer. "Dave" told us how he used an ointment prescribed by the deer lady to heal an older buck with a brain abscess; another resident described using the ointment to treat a doe with a festering wound on her abdomen caused by a pellet gun (M. N. Peterson, field notes, 23 May 2002). "John"

fed a buck for over a year while it was incapable of foraging on its own and continues to care for a doe that was partially incapacitated by an improperly healed leg fracture (M. N. Peterson, field notes, 3 Jul 2000). Similarly, only 3 months into the study, the Miami Herald reported, "one of them [collared deer] has been spotted entangled in the bushes—hanging feet off the ground" (Lynch 1998). The article also cited comments from locals like "it literally brings tears to my eyes to think they're going to put collars on them (deer)."

Although the anthropocentric theme was less dominant, those who saw Key deer from this perspective significantly influenced our ability to capture deer because they typically fed and watered deer. Several property owners tracked genealogy of "their" deer and referred to individuals according to their family position (e.g., grandma, grandpa, momma, baby). When one of these residents discovered our intention to capture several pregnant does on his property, he assured us that they were not actually pregnant. To ease our concerns, he palpated each of them while they foraged on and around his avocado tree nodding and saying "she's already dropped" after rubbing their bellies (M. N. Peterson, field notes, 11 Jun 2002). Bleating fawns elicited responses from spectators of "the baby didn't do anything to you" and "why are you doing this to him" (M. N. Peterson, field notes, 9 Jun 2002). In reference to several other fawns "Anne" said: "they're my little babies and they know if the come by here they can get a little extra nourishment" (M. N. Peterson, field notes, 15 Jul 2000).

**Published Accounts**

Only 16 articles I reviewed provided both capture-related mortality and had ≥ 10 white-tailed deer captures using a single technique. Several studies evaluated multiple methods including box traps (*n* = 4), drop nets (*n* = 2), drive nets (*n* = 3), corral traps (*n* =1), Clover traps (*n* = 5), cannon nets (*n* = 1), rocket nets (*n* = 3), net guns (*n* = 2), oral tranquilizers (*n* = 1), and darting (*n* = 6) (Table 3.1). Mortality associated with box traps, drop nets, Clover traps, rocket nets, and darting was highly variable (0.0–33.3%) both within and between methods (Fig. 3.1). High deer mortality (13.9 and 22.2%, respectively) occurred during the only studies using corral traps and oral sedatives (Hawkins et al. 1967). Conversely, mortality associated with drive nets and net guns was 0–3.6%. Studies using chemical immobilizing agents and/or tranquilizers/sedatives after deer where captured with other techniques, typically resulted in higher mortality than those using only physical restraint post-capture (Fig. 3.2).

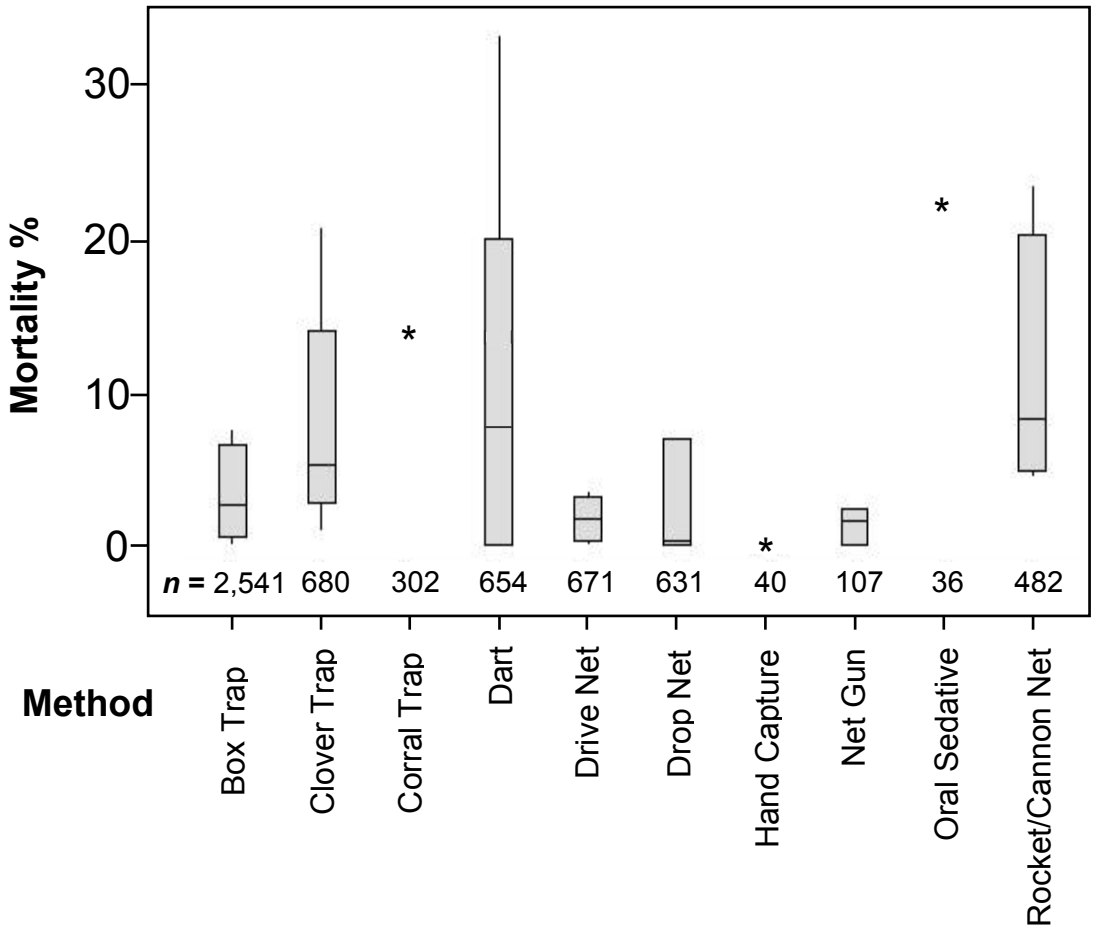


Fig. 3.1. Box-and-whisker plots (boxes show medians and quartiles, whiskers show ranges) of mortality (%) by white-tailed deer capture method. Asterisks represent 1 study per method.

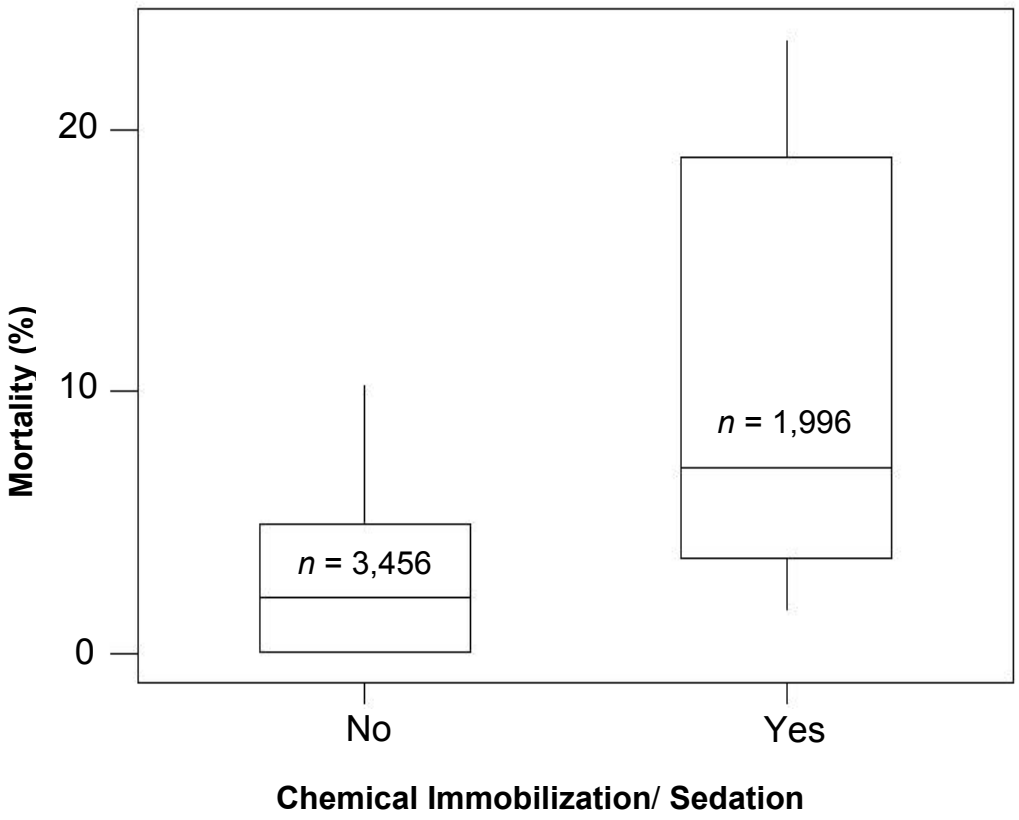


Fig. 3.2. Box-and-whisker plots (boxes show medians and quartiles, whiskers show ranges) comparing white-tailed deer capture mortality (%) between studies not using neuromuscular blocking drugs, general anesthetics, and/or tranquilizers/sedatives and studies using them after capture with a non-chemical related method.

*Box and Clover Traps*.—Mortality associated with the use of box traps varied from 0.0 to 7.6% (Table 3.1). The study reporting 7.6% mortality, however, involved transporting and/or holding deer overnight prior to release (Peery 1968). If the aforementioned study is not considered, 3.3% was the highest mortality reported for this method (Haulton et al. 2001). These deer were immobilized with ketamine hydrochloride and xylazine hydrochloride via intramuscular injection, so the mortality rate attributed to box traps might have been a function of chemical immobilization as well. Studies not using chemical immobilization in conjunction with box traps (Hawkins et al. 1967, Palmer et al. 1980) had lower mortality (Table 3.1), but neither monitored deer post-capture for exertional myopathy-related deaths.

Clover traps also had variable mortality (Fig. 3.1). Clover (1954) reported 0.9% mortality, but did not monitor deer post capture (Table 3.1). Fuller (1990) and Beringer et al. (1996) reported 4.7 and 5.2% mortality, respectively, and monitored deer post-capture. Beringer et al. (1996) might have increased Clover trap-related mortality by leaving some deer in traps for up to 24 hours. The highest levels of capture related mortality occurred in studies using drugs to immobilize deer after capture in clover traps (DelGiudice 2001, Haulton et al. 2001). For example, Haulton et al. (2001) chemically immobilized captured deer with a 1:1 mixture of ketamine hydrochloride and xylazine hydrochloride via intramuscular injection at 1 mg of the mixture per kg body mass, and reported 20.7% capture-related mortality. All documented mortalities were fawns.

*Drop Nets.*—Although we did not experience mortality using the modified drop net (Lopez et al. 1998; Table 3.1), Conner et al. (1987) reported 6.9% mortality using a

slightly larger non-freestanding drop net followed by an intramuscular dose of xylazine. Again, the dangers inherent to the drop net might have been combined with use of sedatives. Further, larger net size, capture of larger groups, and the assumption that 6 animals (50% of their mortality) with unknown fates actually were capture-related mortalities might have increased mortality and/or artificially inflated their mortality estimate. Although Ramsey (1968) did not monitor deer post-capture, his 0.3% mortality suggested that dropping on larger groups of deer ($\bar{x}$ = 10; maximum = 23) did not necessarily result in high mortality.

*Drive Nets.*—Several types of nets and different driving techniques (e.g., Silvy et al. 1975, Sullivan et al. 1991) have been used with consistently low mortality (Fig. 3.1). Sullivan et al. (1991:394) and DeYoung (1988) used large, fixed nets and "hazed" deer by helicopter for up to 9 minutes before capture. We drove deer on foot when using drive nets. Silvy et al. (1975) developed their drive net for urban use, so the lack of mortality in our study may reflect experience gained in the first study. For instance, Silvy (1975) reported 0% mortality in 83 drive-net captures after publication of the aforementioned study (Silvy et al. 1975). Because Silvy et al. (1975) found that injuries were reduced if deer hit the net at lower speeds, we attempted to startle deer into the net after slowly pushing them toward it, rather than driving them at full speed into the net.

*Cannon and Rocket Nets.*—Palmer et al. (1980) reported the highest mortality using rocket nets, but only 1 person stayed at the net and tranquilized captured deer with promazine hydrochloride. Again, risk of mortality from tranquilization and the capture method cannot be separately determined. Additionally, handling time was presumably

longer in their study than for the others where several field assistants were on site and tranquilizers were not used (Table 3.1). Although Hawkins et al. (1968) reported 6.1% mortality, both animals that died had been held >1.5 hours before release. Beringer et al. (1996) and Haulton et al. (2001), however, still reported 10.3 and 4.5% mortality, respectively; so even under more ideal conditions, mortality did not approach 0.

*Darting.*—Chemical immobilization using darts had the highest variability in capture-related mortality (Fig. 3.1). This could be due, at least in part, to improvements in this methodology and drugs over time (Table 3.1). Both the longbow and crossbow were abandoned as darting tools after being involved in studies with high mortality (Table 3.1). Further, federal regulations now require an attending veterinarian for chemical immobilization (Code of Federal Regulations 9, Uniform Rules of Practice for the Department of Agriculture). Thus, the 4 most recent studies (Table 3.1), approaching 0.0% capture-related mortality, were conducted under laws that required experience with these drugs, if not the technique. Moreover, it seems clear that both legal and "moral" constraints now require practitioners of this technique to be experienced (Pond and O'Gara 1996:125).

## DISCUSSION

### Key Deer Capture

In our study of Key deer, positive public relations were critical because we needed to (1) trap deer, (2) track deer, and (3) locate mortalities on private property throughout the study. In urban settings, trapping and monitoring activities must occur primarily on private property. Significant opposition existed between those with

individualistic and anthropomorphic views regarding management because those who saw Key deer as individuals, but not human, opposed giving deer equal status with themselves (Peterson et al. 2002). This opposition did not exist, however, when it came to evaluation of capture methods. Both groups were critical of apparent discomfort to deer caused by capture. They also opposed methods appearing to be violent, regardless of their other merits. Thus, to ensure future access, our capture techniques could not injure or kill individual animals even if major improvements in efficiency could be realized. The publics' individualistic and often anthropomorphic view of Key deer motivated us to choose techniques for each specific capture context based upon the goals of no mortality or injury, passivity, efficiency, and rapid immobilization.

We attempted to tailor methods to minimize negative effects on individual deer by considering age class. For example, we exclusively captured fawns with drive nets because they allowed us to target 1 individual at a time (Table 3.1). This prevented fawns from being injured by struggling adults. Most adult deer captured in urban areas were trapped using a drop net or by hand. Two handlers were available to immediately immobilize each animal, and 3 for handling it prior to release. Residents were not exposed to a deer "rodeo" because animals were quickly immobilized (< 1 min) and processed (5–15 min) using these methods. Deer were handled on a stretcher and materials were clean and organized. When a deer struggled excessively or demonstrated signs of stress we reduced holding time by omitting steps such as taking blood or fecal samples.

The freestanding tension release drop net was the most useful method for capturing urban deer on Big Pine Key (Lopez et al. 1998). It was passive, silent, caused no mortality or serious injury, and the weight of the net partially restrained deer on impact. Further, its freestanding design worked on paved surfaces and could be used on private residences without driving posts into people's yards. The drive net was a valuable tool for catching fawns, which would not respond to bait under the drop net, and "net-shy" deer familiar with the drop net. In the most developed areas, barriers such as fences, buildings, vehicles, and canals made the drive net more effective. Slowly pushing deer toward the net before startling them, and leaving some slack in the net, allowed soft captures. Deer running at full speed were the only ones that sustained abrasions or were flipped, jolted, or twisted enough by the impact with the net to upset spectators. We received some negative feedback when using drive nets because this approach required chasing or at least startling deer. For example, 1 resident would not allow us to attempt capturing pregnant or older deer with a drive net. In fact, some residents suggested hand capture when faced with the possibility of seeing their favorite deer driven headlong into a net. In one instance, when a couple saw us unrolling the drive net, they approached us and said, "you don't need that, they'll eat right out of your hand" (M. N. Peterson, field notes, 4 Jun 2002). They then demonstrated how the doe could be enticed by a piece of raw potato, and gave us a piece to catch "their" deer with. By hand-capturing "tame" deer, time to physical immobilization was less than required for any other methods and deer had almost no chance of injuring themselves. Although "grabbing" deer may be impractical in many settings, hand capture should be considered

where possible in urban settings. When urban deer are accustomed to hand feeding, the method is efficient. It can be dangerous to biologists, however, particularly when attempted with bucks during the rut (Les Pulley, NKDR, personal communication). With 3 handlers we hand captured and immobilized males up to 45 kg and females up to 38 kg, including males in rut, without difficulty or injury to handlers.

The net gun could not be used because citizens perceived it as a weapon, and explosives were frowned upon in suburban neighborhoods. U.S. Fish and Wildlife Service biologists used a net gun (Pachmaur GunWorks, Los Angeles, California) exclusively for Key deer capture prior to our study with moderate success (Tom Wilmers, NKDR, personal communication). They had difficultly catching deer when they stocked deer by foot. Hazing deer with helicopters or shooting out of vehicles in residential areas did not seem prudent and was not attempted. Further, when the net gun was used, citizens often called the law enforcement offices complaining of gunfire (Les Pulley, NKDR, personal communication), so this technique required coordination with local law enforcement personnel.

Residents also viewed dart guns as weapons. In one instance where we attempted to use a dart gun to capture an injured deer, nearly a dozen distraught tourists gathered around asking, “why are you going to shoot it”, and “are you going to kill it” (M. N. Peterson, field notes, 25 Jul 2002). Moreover, dense natural vegetation made darted deer difficult to find (Silvy et al. 1975), and the prospect of drugged deer wandering across roads and into yards deterred us from using this technique in urban areas.

Darts equipped with radiotransmitters alleviate the problem of finding deer (Kilpatrick et al. 1997), but barbed darts require surgical removal. Fourteen percent of the deer Kilpatrick et al. (1997) darted were not found, and 1 dart (3%) was not found. Presumably, these urban deer might have wandered throughout the residential area for several days with a barbed dart hanging from their sides. In the 1 instance, when NKDR biologists attempted to use this technique, the darted buck did not go down and carried the dart in its side while foraging in urban areas for nearly 1 week. Numerous complaints were made to refuge personnel (Helana Cichon, NKDR, personal communication). The buck eventually was captured with a drop net. Further, 1 dart not recovered, depending on the chemical agent used, could represent an unacceptable risk for human safety in urban areas. In our study, 3% would equate to 9 darts potentially containing dangerous drugs lying around residential areas on Big Pine Key.

Human safety issues precluded the use of cannon or rocket nets in close proximity to residences. Human proximity also made Clover and box traps less practical because trapped deer could be exposed to people and pets until we removed them from traps.

**Capture-related Mortality**

From our experiences with Key deer, and published accounts of white-tailed deer capture elsewhere, it appears that several factors other than the capture technique itself influence capture-related mortality (Fig. 3.1). Handling time, workers per animal, experience with the method in question, combining drugs with other methods (Fig. 3.2), study area attributes, environmental conditions, physical condition of individuals

targeted, and monitoring probably all influence mortality. Researchers can control most of these variables, and Haulton et al. (2001) listed recommendations for controlling the problems associated with many of these factors. Although they described how darting and chemical immobilization should be conducted, they did not address whether chemical agents should be used routinely after capture using techniques not involving drugs.

I maintain that acceptance of chemical immobilization and/or tranquilization/sedation as an apparent requisite to deer capture by non-chemical methods is too pervasive in wildlife research. For example, Henderson et al. (2000:904) cited Conner et al. (1987) to support their claim that using chemical immobilization would "minimize capture myopathy". Not only did Conner et al. (1987) not use chemical immobilization (they sedated deer with xylazine hydrochloride), they made no attempt to demonstrate any link between sedating deer and reduced capture-related myopathy. In fact, Conner et al. (1987) provided no rationale for using these pharmaceuticals.

There is little evidence that chemically immobilizing and/or tranquilizing/sedating white-tailed deer after capture with non-chemical techniques reduces capture-related mortality. If anything can be inferred from existing studies, researchers who used these drugs after they captured deer using other techniques reported higher mortality than those who did not (Fig. 3.2). Arguments for chemically immobilizing or tranquilizing deer to reduce stress after capture are suspect. First, stress is rather difficult to quantify for wildlife (Callicott 1980). Further, because some

commonly used agents, such as xylazine, are primarily sedatives, they do not eliminate pain. Similarly, anesthetics do not act immediately, so one must assume that darted deer still feel pain and are under stress until anesthesia is achieved.

Deer often can be handled and released in less time (5–10 min) than it takes for an anesthetic to take effect (this study, Sullivan et al. 1991). High mortality (20.7%) associated with chemical immobilization of fawns (Haulton et al. 2001) suggests that even experienced technicians should question chemically immobilizing fawns unless surgical procedures or other study parameters require doing so. Finally, we must ask: what is the purpose of chemically immobilizing a deer that already is physically immobilized? I suggest following the lead of the medical community in using chemical immobilization only when absolutely necessary. For example, anesthetics might be warranted in studies requiring surgery and certain studies where handling time greatly exceeds induction time, but probably are not required for most other purposes.

Because of the public focus on individual deer, hazing with helicopters, drop nets armed with explosives, and capture-related injury and mortality were not as acceptable for those perceiving wildlife individualistically or anthropomorphically as to the wildlife management professionals. Drop nets, drive nets, hand capture, net guns, and dart guns (Table 3.1) all can be used to capture deer with associated mortality approaching 0. The first 3 methods, however, are more appropriate for urban areas where time to immobilization, human safety, noise, and public perception are critical factors.

## CONCLUSIONS

Although previous management activities associated with Florida Key deer met with public resistance (Peterson et al. 2002), community members did not oppose our radiotelemetry study once it began. Demonstrating respect for individual deer by using capture techniques that yielded low mortality and injury rates and quick immobilization indirectly demonstrated respect for individualistic and anthropocentric viewpoints in the community. This was instrumental to the positive public response to our research. These attributes should be sought in any capture technique used in wildlife research where participation by publics espousing individualistic and/or anthropocentric social constructions for nature. In some ways, the case of Key deer might be perceived as new or unique, but the way Big Pine Key residents viewed wildlife was neither (Berris 1987).

In urban environments, the modified drop net (Lopez et al. 1998), drive net (Silvy et al. 1975), and hand capture might be the most appropriate tools for capturing deer. Although these methods sometimes are more labor intensive, they result in nearly 0% mortality and are perceived favorably by the public. Any increased labor costs should be weighed against future costs to the wildlife profession created by using methods more likely to kill or seriously injure individual white-tailed deer in full public view. If the public experiences the dramatic death of a fawn, for example, an urban white-tailed deer study with even 1.0% mortality could negatively impact future wildlife research in the area for years to come. Conversely, studies of urban deer that require capture can improve public perception of wildlife research if they are tailored to demonstrate respect for individual deer and public perceptions of the deer.

The aforementioned attributes are mandated in part by public involvement, but we must remember that deer capture conducted in rural areas essentially becomes public when published in scientific journals or elsewhere. Undoubtedly, techniques involving helicopters, dart guns, or cannon and rocket nets are more acceptable in rural environments, but techniques resulting in high mortality or injury rates are not. Since several deer capture techniques can be used with nearly no mortality (Fig. 3.1), this should beg the question of whether we can justify deer capture resulting in >1% mortality to a public that values animals as individuals. Perhaps we can, but in such circumstances the justification should be explicitly stated.

Improvements in capture techniques discovered during studies with other objectives certainly are valuable to the wildlife community, but should be published with the caveat that evaluating mortality and stress associated with techniques was not the primary motivating factor behind the research. I assumed statements about tooth extraction, tagging, weighing, and collaring indicate that other research objectives, such as population age structure, health, and density estimates, were implicit in reviewed studies. However, the belief that wildlife biologists, let alone the public, will understand that these deer were captured for other purposes is probably an unfounded assumption. A statement such as “to obtain animals for an ecological study using radio telemetry, it was necessary to develop a safe but productive capture technique”, would be ideal (Silvy et al. 1975). Our argument is not directed toward physiological research, but rather at the circular logic inherent in the idea that deer should be captured to determine how much capture hurts them. The constant need for demographic information on wildlife

populations provides ample opportunity to evaluate innovations in capture techniques. Studies conducted solely to determine the levels of mortality, stress, or other animal suffering caused by research techniques should cease.

Although white-tailed deer capture techniques have evolved to the point where researchers have several ways to capture deer with nearly no injury or mortality, the situation may be different for other species. Methods known to be dangerous, however, should not be tested merely to provide comparisons with new methods. Statistical differences among mortality associated with various capture methods are not as important to the public, or the scientific community, as 0 mortality. I am are aware that chance events will preclude this possibility in some studies, but this should be the goal, not demonstrating statistical differences. The wildlife profession is answerable to an ethic generated by society at large even if we do not espouse it in its entirety. We should regulate ourselves regarding research techniques and goals before others regulate us. Although population-community and individualistic paradigms cannot be reconciled in all research situations (Callicott 1980), they should be carefully balanced, particularly where urban wildlife capture is concerned.

# CHAPTER IV

# KEY DEER FAWN RESPONSE TO URBANIZATION

## SYNOPSIS

Assuming a finite biosphere can support infinite development seems logically indefensible, yet the concept of sustainable development has become a dominant conservation paradigm. The story of endangered Florida Key deer appears to support the legitimacy of sustainable development because Key deer numbers have increased 240% since 1970 while the human population in their habitat has increased nearly 10-fold. Because fawn mortality is considered the primary density-dependent factor regulating cervid populations as they approach carrying capacity, I hypothesized changes in fawn demographics could elucidate the fallacy in assuming development was sustainable on Big Pine Key. I determined and compared survival and range sizes for Key deer fawns between 1968 and 1972 (early development) and 1998–2002 (post-development). Fawn ranges (95% probability area, 135 to 30 ha) and core areas (50% probability area, 23 to 6 ha) decreased during this period of development while survival increased (0.47–0.96). All fawn mortality was anthropogenic. The positive relationship between fawn survival and development may be a function of isolating fawns from anthropogenic mortality with increasingly smaller ranges. If this is true, the relationship is not sustainable because shrinking ranges will eventually lack sufficient resources to support a fawn.

## INTRODUCTION

Increasing human population and demands for improved standards of living combined with limited habitat for wildlife, leads to conflict over economic, political, and

social costs associated with use, wise or otherwise, and/or preservation of the natural environment (Peterson et al. 2002). Assuming a finite biosphere can support infinite growth of the human enterprise seems logically indefensible, but in our efforts to have the cake and eat it too we have embraced the concept of sustainable development (Peterson 1997). Although this concept has no universally accepted definition, its application in wildlife management has taken the form of substituting technological advances and creative management for dwindling areas of suitable habitat. Governmentally sanctioned processes, such as habitat conservation planning, legitimize efforts to support development and maintain sustainable wildlife populations.

Endangered species management provides a focal point for clashes between sustainability and development because it creates a rare situation where sustainability of wildlife populations has legitimate precedence over development. The exponential growth of habitat conservation planning (Allison 2002) represents either an attack on this rare bastion for sustainability or a means to realize truly sustainable development. Upon first glance the story of the endangered Florida Key deer supports the legitimacy of the latter interpretation.

Urban development in the Keys has been a concern in the recovery and management of Key deer for the last 3 decades (Klimstra et al. 1974). Since 1970, the human population (≈ 500) has increased nearly 10-fold on Big Pine and No Name keys; in 2000, the resident population was 5,032 people with an influx of 1,000–1,500 tourists during winter (Folk and Klimstra 1991*b*, Lopez et al. 2003, U.S. Census 2000). Scientists suggested development and urbanization of Key deer would lead to higher

rates of deer-vehicle collisions (Folk and Klimstra 1991*b*) and disease transmission (Nettles et al. 2002). Comparisons to baseline data (1968–1972) indicate urbanization has had little effect on adult Key deer survival (Lopez et al. 2003), and during this period of massive development, the Key deer population continued to grow nearly 240% (Lopez 2001).

With the exception of the Columbian sub-species (*O. v. leucurus*; Ricca et al. 2002), white-tailed deer management supports the concept of sustainable development. White-tailed deer have rebounded from near extirpation in the early 1900s to overabundance during a period of unprecedented urban and suburban expansion (McShea et. al. 1997). However, the relationship between urbanization and Key deer population growth probably operates on a law of diminishing returns (Lopez 2001). Growing populations should combine with shrinking "useable" space (Lopez et al. in review, Guthery 2002), to increase density. I hypothesized this would lead to smaller fawn ranges and higher mortality.

Fawn mortality is considered a primary density-dependent mechanism regulating cervid populations as they approach carrying capacity (McCullough 1979, Clutton-Brock et al. 1987, Sams et al. 1996), so changes in fawn mortality and range size should manifest themselves first. Little demographic information exists for Key deer fawns (< 6 months of age, Lopez et al. 2003), so, I determined range size and survival for early-development (1968–1972) and post-development (1998–2002) fawns. I tested my hypothesis by comparing early-and post-development fawn range size, survival, and mortality causes. Specifically, I evaluated (1) ranges, (2) survival, and (3) mortality

factors. Our objective was to determine if smaller ranges and higher mortality followed increased density for Key deer fawns.

**METHODS**

Key deer fawns were live-trapped and radio-collared between 1968–1972 and between 1998–2002. Fawns were captured using portable drive nets (Silvy et al. 1975), and hand-held dip nets (Silvy 1975). We used physical restraint to hold fawns after capture with an average holding time of 5—10 minutes (no drugs were used). Sex, capture location, body weight, radio frequency, and body condition were recorded for each fawn prior to release. We fitted each fawn with expandable breakaway battery-powered mortality-sensitive radio transmitter (15 g, Advanced Telemetry Systems Incorporated, Isanti, Minnesota) collars (Lopez 2001).

Fawn locations were determined via homing (White and Garrott 1990, Lopez 2001) 6-7 times per week at random intervals (24-hour period was divided into 6 equal 4 hour segments; 1 (4-hour) segment was randomly selected and during that time all deer were located [Silvy 1975]). Fawn (< 6 months) ranges (95% probability area) and core areas (50% probability area) were calculated using a fixed-kernel home-range estimator (Worton 1989, Seaman et al. 1998, Seaman et al. 1999) with the animal movement extension in ArcView (Hooge and Eichenlaub 1999). Calculation of the smoothing parameter (kernel width; Silverman 1986) was used in generating kernel range estimates. Differences in ranges and core areas were tested using a *t*- test where values were considered significant at $P \leq 0.05$ (Ott and Longnecker 2001).

Radio-collared fawns were monitored for mortalities 6–7 times per week. Mortality signals were immediately followed by walk-ins to determine cause of death from evidence at recovery sites. All carcasses were necropsied using procedures described by Nettles (1981). Animals were censored from the data set after last known encounter when radios failed (Pollock et al. 1989).

Peak fawning for Key deer occurs in May (Hardin 1974), and fawn survival was calculated through November. Thus, our 6-month survival estimates are conservative because they may reflect mortalities occurring during the first 7 months. Survival data were analyzed using the Kaplan-Meier model in the program Ecological Methodology (Krebs 1999). I compared baseline (1968–1972) and post-development survival (1998–2002) using the log-rank test (Pollock et al. 1989). Sexes were pooled due to small sample size (White and Garrott 1990) with tests of the null hypothesis (equal survival) being conducted at $P = 0.05$.

**RESULTS**

We captured and radio-marked 55 Key deer fawns during both studies (historic, 7 females, 19 males; current, 8 females, 20 males). No fawns died during capture or from capture-related mortality. Fawn ranges decreased dramatically (135 to 30 ha) since the early-development period (Table 4.1). Current ranges were significantly ($t = 2.73$, 26 df, $P = 0.011$) smaller than historic ranges. Fawn core areas decreased in size from 23 to 6 ha since the historic study, and current core areas were significantly ($t = 2.22$, 27 df, $P = 0.035$) smaller than historical core areas.

Radioed fawns were tracked for 199 total months (9 deaths, 23 censors, 167 survivals), and all censored months reflected radio malfunction or a lost signal. Historical fawn survival (0.47) was lower than current fawn survival (0.96; Table 4.1), but the difference was not statistically ($X^2 = 1.720$, 1 df, $P = 0.196$) significant. Censoring fawns that drowned from the sample did not significantly ($X^2 = 2.270$, 1 df, $P = 0.147$) raise historical survival but did raise it by 30% nonetheless (Fig. 4.1). Small sample size precluded other statistical comparisons.

All mortality detected in these studies was caused by drowning in mosquito ditches or deer-vehicle collisions. Drowning (6 mortalities; early-development study) occurred in April and May while deer vehicle collisions (2 early-development study, 1 post-development study) occurred in September and October. No "natural" fawn mortality has been reported to USFWS or documented by researchers. All fawn mortality has been human related (i.e., dog mauling, fawn vehicle collision, entanglement in fencing or netting, or drowning in canals and mosquito ditches).

Table 4.1. Early-development (1968–1972) and post-development (1998–2002) survival, range, and variance estimates for radiomarked Florida Key deer fawns ($n$ = 55).

| | Early-development | | Post-development | |
|---|---|---|---|---|
| Parameter | $\bar{x}$ | SE | $\bar{x}$ | SE |
| Survival | 0.47 | 0.13 | 0.96 | 0.04 |
| Range (ha) | | | | |
| 50% | 23 | 7.51 | 6 | 1.67 |
| 95% | 135 | 37.80 | 30 | 7.39 |

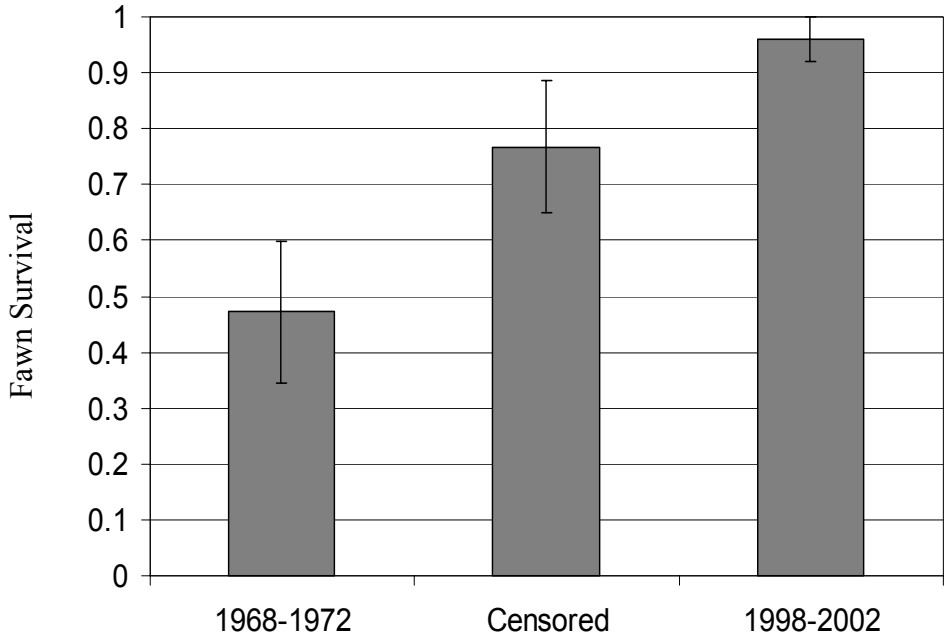


Fig. 4.1. Key deer fawn survival. Early-development (1968-1972), early-development with drowning deaths removed (censored), and post-development (1998-2002) with error bars (±1 SE).

## DISCUSSION

The dramatic decrease in fawn range size since the early-development study supports our contention that higher density would lead to smaller ranges. However, the comparison of survival rates did not support our hypothesis that smaller range size would equate to higher mortality. Although post-development survival was higher, censoring drowning in mosquito ditches yielded similar pre- and post-development mortality (Fig. 4.1). A maze of 30-cm wide and 1-2 m deep ditches was dredged through low lying areas on Big Pine Key in the 1950s to facilitate saltwater intrusion into freshwater holes serving as mosquito breeding sites (Hardin 1974). After the historic study of Key deer fawn survival, USFWS personnel manually filled many ditches and siltation over the last 30 years filled others. The filling of mosquito ditches by USFWS personnel may have contributed significantly to improved fawn survival. A 3-month study (Mar–May 1999) failed to find any fawns or fawn remains in mosquito ditches (USFWS, unpublished data), and no fawn drowning occurred in our post-development study.

The role of cover for Key deer fawns may explain why a 75% reduction in range size did not increase mortality. Predators like coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) traditionally implicated in fawn mortality (Ricca et al. 2002) are absent in Key deer range, so predation pressure is slight if it exists at all. While abandonment, disease, and malnutrition probably influence fawn mortality, their influence is undocumented.

Key deer fawn “predators” (cars, pet dogs, fences, and soccer nets) rarely infiltrate hammocks. Key deer fawns are not hunted, but expose themselves to mortality

hazards in urban areas as they move through their range. The lack of correlation between Key deer fawn mortality and smaller ranges may be a function of how much urban area is included in the average fawn's range. Higher deer density and the resulting smaller ranges may isolate some fawns from anthropogenic mortality. This process is supplemented by infilling of previously suitable habitat inside sub-divisions (Lopez et al. in review). In-filling of sub-divisions and smaller range size may mask the increasing impacts of development by forcing fawns out of urban areas where mortality is highest and reducing the probability that an individual fawn will be exposed to fixed hazards like soccer nets, canals, and roads. Further, lower speed limits and increased awareness of Key deer management within the community (Peterson et al. 2002) may have reduced the proportion of fawns killed in deer-vehicle collisions even with the higher traffic levels associated with development. Finally historical development may have increased carrying capacity (Lopez 2001) by increasing availability of limiting factors like water and upland area (Hardin 1974).

As development encroaches on suitable habitat, deer density will continue to increase with a concomitant decline in fawn range size. Survival may remain high for a short time but eventually shrinking ranges will cease to provide sufficient sustenance. Nettles et al. (2002) reported the Key deer population was at or near carrying capacity based on observed abomasal parasite counts. If this assessment is accurate, the relationship between fawn survival and development will be reversed.

## MANAGEMENT IMPLICATIONS

Anthropogenic changes on Big Pine and No Name keys are blamed, correctly, for the historical plight of Key deer (Lopez 2001). Although they also are considered the greatest danger to Key deer population viability (Lopez et al. 2003), our results indicate that careful management and conscientious driving habits of new, human residents on these islands have allowed a concomitant increase in fawn survival and urban development over the last 30 years.

Development and fawn survival, however, cannot be positively correlated after carrying capacity is reached. This conclusion seems intuitive for Key deer because they live on small islands. Wise management practices can only facilitate the co-occurrence of development and wildlife conservation for a limited time on a 2,548 ha island. If every hectare is paved no Key deer can survive. A fulcrum exists where 1 more house will reverse the positive relationship between development and sustainability for the Key deer population. Development in the Keys crossed that fulcrum years ago regarding wildlife species less tolerant of development like the endangered Lower Keys marsh rabbit and Key Largo woodrat (*Neotoma floridana smalli*).

Property rights advocates are unlikely to accept limits on development (Peterson et al. 2002) and will argue for sustainable development particularly in areas where it's logical fallacy is less obvious than on islands. Limits on development and eventually its cessation, however, are necessary for saving Key deer. The earth and it's over 6 billion people are no different than Big Pine Key and it's over 5,000 people. Both are islands, and on both islands, sustainable development will be revealed as a myth

1extinction at a time. Humans and Key deer fawns are doing better with fewer natural resources, but neither species has a sustainable future unless development, defined as growth, eventually stops.

# CHAPTER V

# MORAL CULTURES IN CONFLICT

## SYNOPSIS

Conflict regarding the conservation and preservation of natural resources is among the greatest challenges of the 21st century. Given that management of natural resources increasingly depends on securing cooperation of culturally diverse groups of people, it is important to understand how to secure that cooperation. Endangered species management on private lands both typifies and magnifies the environmental conflicts encountered by natural resource policy makers and managers. Using an ethnographic approach, I analyzed the conflict surrounding management of the endangered Florida Key deer to explore how conflict and moral culture apply to natural resource policy formation and implementation. I found disputants on Big Pine Key divided into 2 moral cultures, 1 grounded in stewardship and the other in private property rights. These moral cultures augmented the conflict by perpetuating divergent ethical perspectives and aspirations. The conflict then escalated through deindividualization, dehumanization, and demonization of those informed by the opposing moral culture. Finally, as typically occurs with serious conflicts, incompatible frames of reference created by the cultural divide not only prevented rapid de-escalation, but promoted conflict reinforcing mechanisms such as selective perception and judgment, moral exclusion, and rationalization, which led to communication breakdown and autistic hostility. Temporary solutions to superficial problems that were maladapted to conflicts involving moral culture did not ameliorate conditions, and often exacerbated them. In emotionally

charged decision-making venues, wildlife managers should take a proactive approach designed to encourage collaborative development of common ground among disputants. When conflicts reach a highly escalated state, as many inevitably will, their resolution will require meeting appropriate pre-negotiation conditions, then applying strategies that respond to both the level of escalation and the moral cultures involved in the particular conflict.

**INTRODUCTION**

Conflict, or expressed disagreements between people who see incompatible goals and potential interference in achieving these goals, regarding the conservation and/or preservation of natural resources is one of the greatest challenges of the 21st century (Lee 1993, Peterson 1997, Daniels and Walker 2001). Conservation involves deciding which ecosystems, landscapes, habitats, and species deserve protection or other forms of management. It also involves determining the level of resource allocation appropriate for each objective. Increasing human populations and demands for improved standards of living, combined with limited natural resources, lead to conflict over economic, political, and social costs associated with use, wise or otherwise, and/or preservation of the natural environment. Many disagreements over management of natural resources are amenable to straightforward resolution strategies. Examples might include disagreements over allocation of irrigation water, the minimum size required for a building lot, or strategies a municipality should use to achieve compliance with federal air quality requirements. Although most of those involved in such disagreements may not be pleased with the outcomes, neither will they continue to brood over them. More serious conflicts occur

when people fail to agree on whether water should be used for irrigation, whether building of any kind should be allowed in a certain location, or whether it is appropriate for the federal government to set air quality requirements for individual municipalities.

One characteristic of serious environmental conflict is that it is firmly rooted in moral authority, or the basis people use to determine whether something is good or bad, right or wrong, acceptable or unacceptable. Moral authority regarding the environment is inextricably intertwined in culture, or "the basic premises of belief and value that people share in public life in order to recognize who they are and of what they are a part" (Carbaugh and Wolf 2000:24). The ethical grounding of any culture enables it to define all human actions believed to be significant as either moral or immoral. It is only a small step from identifying all actions in this way to identifying people themselves as moral or immoral, based on cultural norms. Accordingly, environmental conflict often becomes cultural conflict, or political and social hostility rooted in different systems of moral understanding. Although the cultures involved in environmental conflict often include ethnic, religious, and socioeconomic dimensions, they are more consistently moral cultures. I use the term moral culture to describe the process whereby moral authority unites people with diverse educational, ethnic, or religious backgrounds to achieve a shared group identity. Opponents in a clash between moral cultures differ in wants, beliefs, and needs, and lack shared methods for arguing claims and judging the validity of those arguments.

Environmental conflicts tend to be difficult to manage, in large part, because moral culture rarely is factored into decision-making models. Even if one were to accept

the unrealistic assumption that it is possible to make management decisions in a political and social vacuum (e.g., based solely on natural science), there is no reason to presume this would be desirable. Application of the scientific method often fuels rather than mitigates environmental conflict, because cultural values, more than scientific discoveries, motivate society (Botkin 1990:3-8, Peterson 1997:34-53). Participants in environmental disputes often find themselves involved in holy wars over the proper relationship between humans and other species. Specific policies are forgotten, as participants polarize into opposing camps, each justified by bedrock values. In this study, I analyze the Florida Key deer management controversy surrounding land use in the lower Florida Keys to clarify the cultural dimensions involved in many environmental disputes.

Regarding environmental disputes, at least 2 opposing moral cultures have developed in the United States, both rooted in the nation's origin myth. Good government and laws were assumed to derive from a higher source, either God or nature (Bellah 1992:27). Thomas Jefferson combined these ideas in the beginning of the Declaration of Independence referring to "laws of nature and of nature's God" (Bellah 1992:27). One perspective, grounded in John Locke's work, argued that good government was derived out of a contract for mutual defense of private property (Bellah 1992:30). Thus, property ownership was proposed as a prerequisite for voting. A second view, based in Calvinist theology, assumed good government was rooted in social responsibility and individuals should be willing to deny themselves for the greater good of the community (Bellah 1992:30–31).

The moral culture rooted in the Calvinist interpretation was modified and popularized by Theodore Roosevelt and John Muir (Oravec 1981, 1984; Dorsey 2003). Roosevelt and Muir argued that nature was a catalyst for lifting humanity intellectually and spiritually. Further, Roosevelt expanded the U.S. frontier myth (Peterson 1990, 1991; Slotkin 1998) to include yeomen farmers who conserved finite resources for others to use, as well as the traditional conqueror heroes (Dorsey 2003). Although this new perspective took decades to find broad acceptance among the U.S. public, it is prevalent today. The Christian stewardship interpretation of the book of Genesis also played an important role in preservationist ideology (Cox 1992). This interpretation assumes a sacred stewardship was passed to humankind with the command to subdue the earth and have dominion over every living thing upon it (Genesis 1:28). So, within Calvinistic moral culture stewardship is mandated as both a social and spiritual responsibility. One effect of this idea can be seen when persons espousing preservationist ideals characterize those without such ideals as intellectually and morally deficient. Because participants in the Florida Key deer management controversy who identify stewardship as their core value tend to support preserving natural habitat, I subsequently refer to adherents of this moral culture as preservationists.

Alternately, moral culture grounded in the sanctity of individual freedom, rather than in responsibility to the group, often translates into an emphasis on private property rights. Locke's conception of the role of private property in modern society forms the theoretical justification for most private property rights advocacy (Bellah 1992:30). This moral culture derives from the U.S. tendency to equate property rights with democracy

(Peterson and Horton 1995). Private property is thus seen as an inalienable human right on par with "life, liberty, and the pursuit of happiness." Contemporary proponents of property rights typically base their claims on the Fourth Amendment to the Constitution, which reads:

> The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

Just as Roosevelt's reinterpretation of the frontier myth opened new possibilities for the concept of stewardship, the Federalist principles espoused by Chief Justice John Marshall's Supreme Court provided a foundation for the sanctity of private property. Marshall's decisions, beginning with Fletcher v. Peck in 1810, were the first to proclaim Constitutional protection for private property interests (Kraus 1959:308-311, Morison and Commager 1962:350-450). Because participants in the Key deer controversy who identify individual rights as their core value tend to support the rights of individual property owners, I subsequently refer to adherents of this moral culture as private property rights advocates (PPRAs).

Both the perspectives of PPRAs and preservationists are distinctly moral cultures drawn from texts that, while subject to various interpretations, pervade U.S. politics, law, and society in general. Belief in the literal sanctity of the Bible or the Bill of Rights is peripheral to their cultural power, for moral culture only requires that its

adherents espouse the moral imperative derived from these foundational texts. Endangered species management provides a microcosm of the conflicting moral cultures faced by natural resource managers in the United States. As it has been interpreted and implemented, the Endangered Species Act (ESA) magnifies environmental conflict (Yaffee1982:149-162, 1994; Peterson and Horton 1995). The discourse of the USFWS, which is legally mandated to manage endangered species, typically ignores cultural practices (Peterson and Horton 1995), and not surprisingly fails to consider their implications for management decisions. Because this aspect of ESA enactment has been ignored, antagonists in conflicts ranging from the northern spotted owl (*Strix occidentalis caurina*) to the Florida Key deer have become so deeply entrenched in positions espoused by their moral culture that negotiation becomes ineffective at best. This phenomenon is further magnified and complicated when agencies faced with insufficient funds to procure suitable habitat attempt to preserve private property for endangered species habitat (Peterson and Horton 1995). The long-standing conflict regarding Florida Key deer management on Big Pine Key exemplifies moral conflict inspired, and exacerbated, by endangered species management on private lands.

Given that management of natural resources, particularly those associated with private property, increasingly depends on securing cooperation of culturally diverse groups of people, those attempting to secure that cooperation should understand how moral authority enables a culture to iteratively make and justify decisions regarding how to interact with each other, as well as with non-human species. In this study, I use the controversy surrounding management of the Florida Key deer as a case study to improve

my ability to reach this goal. Within the previously defined framework of conflict and moral culture, I describe an ethnographic research approach directed toward determining how the conflict occurred and was reinforced, rather than simply identifying conflict components, in an attempt to broaden my understanding of the social dimensions of wildlife management. I then outline how framing and escalation of conflict on Big Pine Key followed a predictable pattern for conflicts attenuated by moral and cultural differences. By discussing how decisions made without knowledge of this pattern limited past attempts to ameliorate the conflict, I illuminate the value of such knowledge. Finally, I describe conflict resolution strategies based on an awareness of conflict and moral culture and suggest implications for enabling land managers to integrate social systems and ecosystems within natural resource management plans.

## METHODS

### Perspective

This project is an attempt to understand and explain how human communication influences group formation and activities pertaining to environmental conflict. Accordingly, it is grounded in social construction theory, which explains how experience shapes people's perception of reality and how language is used to construct that reality (Gergen 1985, Lincoln and Guba 1985, LeFevre 1987). Social constructionism argues that knowledge is not acquired free of culture, history, and social context. Rather, linguistic interactions among individuals produce reflexive understanding (Lincoln and Guba 1985, Lange 1990, Ray 1996). Similarly, negotiated understanding among groups and cultures develops through the medium of language

(Gergen 1985, 1994*b*; LeFevre 1987; Peterson and Horton 1995). Social constructionism confronts the idea that language represents objective truth with the claim that words acquire meanings in contexts created by historical patterns, as well as current interactions among individuals; they are used to reward, blame, censure, and assign responsibility. Finally, the conventions of discourse within a society shape how language is understood and how it affects human action (LeFevre 1987, Gergen 1994*a*, Peterson and Horton 1995). Although different theorists emphasize different aspects of the social construction process, all converge around the claim that language is constitutive rather than simply reflective of social reality.

Any conflict is attenuated and complicated by the moral dimension of cultural differences (Rubin et al. 1994:11-26). Culture affects all stages in conflict development. It encourages the development of incompatible aspirations that define the conflict, influences the surfacing of conflict because some individuals avoid it while others embrace it, and also influences which potential strategies parties use to address the conflict (e.g., avoidance, contentiousness, yielding, or problem solving) by influencing rigidity of aspirations and perception of common ground. Disputants from different cultures typically lack common rhetorical systems, traditions, stories, and symbols. The frustration and aggression that develop from the resultant communication failure promote rapid escalation of the conflict (Pearce and Littlejohn 1997:111). Escalation begins with fear, anger, and blame being directed at the other party, which then foments negative images and attitudes (Rubin et al. 1994:68–97). Parties then deindividualize, dehumanize, and even demonize each other. These negative images in turn create

reinforcing mechanisms that serve to perpetuate the conflict (Rubin et al. 1994:98-116). I label these mechanisms: (1) selective perception and judgment, (2) moral exclusion and rationalization, and (3) a breakdown of communication and autistic hostility.

**Ethnographic Approach**

Because the conflict I examined was so dependent on collaboration among area residents, I used an ethnographic approach for my analysis. Ethnography, which draws its strategies for analyzing linguistic codes and social performance from folklore and sociolinguistics, is broadly concerned with how communication practices relate to social structures (Anderson 1987, Ray 1996, Downes 1998, Yarbrough 1999). It provides a direct means for examining interactions among and within social groups (Lindlof 1995, Ray 1996). The ethnographer immerses him- or herself thoroughly in the social context, taking on the role of student, to request that participants teach the researcher how to interpret the situation. The ethnographic regard for context enables the researcher to discover the importance of moral authority, culture, and ultimately the moral culture as they pertain to group identity performance. Clearly understanding the practices of group identity and performance should enable natural resource managers to minimize the negative aspects of environmental conflict, while developing more effective strategies for involving human communities in natural resource management policy formation and implementation. First name pseudonyms were used for all informants other than governmental officials or members of the media, as a means of complying with Institutional Review Board confidentiality requirements at Texas A&M University and standard reporting procedures for qualitative research (Anderson 1987, Morse 1994). I

used the following system to identify quotations from interview transcripts: Pseudonym, Interview number, Utterance. For example a quotation identified as (Scott, I5, U4) came from the fourth utterance within interview number 5, and was spoken by the informant identified as Scott.

Ethnographic researchers rely on a variety of techniques to manage issues of accuracy (bias and precision). Freedom from bias, or the extent claims conform to actual features of group action and interaction can be improved through triangulation in data collection and informant validation (Anderson 1987, Silverman 1993). Informant validation can take several forms, including designing clarification questions into the interview protocol, conducting multiple interviews with the same informant, and asking informants to critique conclusions from past and current analyses of the situation. The quality of contacts with informants, number of informants, and time in the field also decrease bias. In this case, I achieved triangulation by combining individual interview transcripts, field notes taken while living within the social situation, and summaries of historical accounts. Informants participated in multiple interviews and critiqued tentative conclusions. The interview protocol also included clarification questions. Documenting informants' stories in their own words further limited the potential for bias.

Precision, or the consistency of the methodological instrument in recording data, is a more complex challenge (Lincoln and Guba 1985, Anderson 1987, Lindlof 1995). Ethnographic researchers recognize that, as socially situated humans studying other socially situated humans, they are neither value neutral nor unresponsive to contextual sites. This means the ethnographic researcher is the principal methodological instrument,

and her or his interactions with informants becomes part of the research (Lincoln and Guba 1985, Lange 1990, Ray 1996). Continual movement between data collection and analysis allows researchers to evaluate the precision of recorded explanations (Lincoln and Guba 1985, Ray 1996). This repeated interface encourages the reflexivity so essential to any explanation of situated social action (Luhmann 1989:15-31, Gergen 1994*b*, Peterson 1997:34–53). Preparation for this analysis included studying previously compiled reports, news coverage, and transcripts of public meetings. Reflexivity was further heightened by reexamination of ongoing news coverage, public meetings, and transcripts of previous interviews, as well as constant comparisons between field notes and interview responses. This enabled informants to guide the interview protocol into issues that the original interview questions had not considered, as well as to clarify previously vague concepts, and to verify or refute researcher interpretations of events. It also provided a point of comparison for examining the nuances of the practices in which informants engaged when negotiating and performing their group identities.

After establishing the research question and site, I located and contacted influential members of local interest groups. Because his research was directed toward providing a more reliable ecological basis for a Habitat Conservation Plan on Big Pine Key, R. R. Lopez was able to provide a list of active and informed members of the local community. Notes taken while attending meetings of local groups involved in the conflict supplemented both individual and group interviews with conflict participants. Gaining access to those informed by preservationist cultural values proved easy—they went out of their way to facilitate the interview process. Negotiating access to those

grounded in PPRA perspectives was more difficult. Telephone calls requesting interviews went unanswered until Scott, an influential member of the business community, broke the impasse. After hearing that R. R. Lopez was affiliated with the project, Scott agreed to participate. During his initial interview, Scott took the role of teacher, explaining his perspective regarding how the conflict began, the motives behind various interest groups, and why it had become so difficult for people to consider crossing the boundaries to work with those who had become enemies.

Scott was pleased with the experience and spread the word among his colleagues and associates. A few days later, Scott reported that when Wayne, 1 of his associates, had mentioned receiving a telephone message requesting an interview, Scott had enthusiastically described his own interview experience. Scott's assurances that the researchers actually wanted to understand the situation from his perspective overcame Wayne's earlier reservations. He eagerly agreed to a second request and scheduled an appointment for the next morning. Wayne gave an hour-long interview and got angry when his secretary interrupted him for a previously scheduled meeting. After this point, the PPRA community welcomed the opportunity to share their perspective. The project included formal interviews with 20 informants, roughly half from each moral culture, and informal interactions with many more.

Ethnographic research protocol requires that conclusions drawn from structured interviews such as those conducted for this project must be verified through repeated and informal interactions between researcher and informants (Lincoln and Guba 1985, Lange 1990). Although some informants were ecstatic about the chance to speak openly about

the conflict, many were hesitant to be candid, even within the constraints of a confidential interview. Others indicated that although the interviews were designated as confidential, they could not speak forthrightly because of their positions. Outside of the formal interview setting, however, these community members often used more explicit language, even contradicting statements they had made during their original interview. Detailed field notes of interactions with local conflict participants enabled constant comparison between statements informants made in various settings. In the case of direct contradictions, informants were asked for clarification. Interviews evolved into conversations as the conflict participants began to accept interviewer curiosity as nothing more than a desire for understanding. Over time, our relationship changed in 2 ways. Most pertinent to this research was their increased trust and willingness to explain the internal logic, as well as the strategic components of their cultural perspective and public statements. Secondarily, because they saw the interviewer as a reasonable person, they attempted to use the interview setting to persuasively present the inherent validity of their perspective. Thus, field notes and interview transcripts provided the core ethnographic data. Radio and newspaper accounts, unpublished state and federal agency reports, and personal correspondence supplemented the field notes and interview transcripts. Although I evaluated media dating back to the creation of the NKDR in 1957, most information related to events since 1985. Radio accounts were transcribed from tape-recorded broadcasts obtained from William Becker, news anchor for 104.7 FM, WWUS. The NKDR kept files of local, state, and national newspaper articles

pertaining to the refuge. I evaluated all articles pertaining directly to the conflict. I also obtained and evaluated Bidol-Pavda's (1992) conflict assessment.

## ETHNOGRAPHIC ANALYSIS

Typically, cultures create a system of morals that defines right and wrong. Thus, people with diverse educational, ethnic, or religious backgrounds come to share beliefs and values in public life that create both individual and group identities. As is often the case in environmental conflict, the moral cultures of those living on Big Pine Key extended this process into a spiral of escalation. Once cultures create a system of morals, those morals begin to mandate cultural practices.

### Cultural Divide

Every PPRA informant interviewed expressed concern that the Key deer were being elevated to a moral status superior to humans. The PPRAs also expressed this sentiment in the records of every public meeting reviewed. Comments such as "when the deer are more important than the people there is something out of whack" (Scott, I4, U11) were common. Residents repeatedly claimed that their concerns regarding how their property rights were being violated went much deeper than economics. One woman, speaking in the 1992 Big Pine Focal Point hearings, chronicled her happy life on Big Pine Key, then pointed out that fair market value could never pay for her home because it was part of who she was and could not be found elsewhere. This perspective was dramatically illustrated in a public meeting convened by the USFWS at the Big Pine Christian Center on 23 August 1989. Only 2 speakers caused the moderator to lose control of the meeting. When a representative of the Wilderness Society stated that a

public opinion survey indicated Big Pine Key residents wanted accelerated land acquisition by the refuge, a disturbance ensued as audience members yelled out accusations of lying. Later, a participant challenged panel members to support the Assistant Refuge Manager's claim that "owning property is not a right in this country, it's a privilege just like owning a drivers license." After a slight commotion, the Assistant Manager for Florida Refuges responded that it must have been a "misrepresentation as to his comment." An audience member interrupted the Assistant Manager of Florida Refuges, shouting, "the statement was made to me." The moderator called for order, pleaded for the audience to follow the meeting format, and attempted to call the next speaker. The commotion did not subside, however, until the offended citizen obligingly offered to wait for his turn. This sentiment, that property rights transcended economics, was widely shared. An informant said "I don't think there is anyone on Big Pine who does not love the Key deer … I wouldn't want to see rampant development … but I'm also for property rights" (Ruth, I10, U36).

Alternately, preservationist informants viewed any freedom, including the freedom to manage one's private property, as meaningless without responsibility. They appealed to "higher" motivations, such as unselfishly working toward the greater good of the nation and ideals that were larger than the individual. One couple told me, "it's not just an indebtedness to a stewardship [of nature], it's indebtedness to other Americans." They extended this contention by claiming that those who fought preservation were "anti-American" (Celina, I1, U17). For them, those who failed to protect the Key deer, which many equated with nature (Lopez et al. 2002), failed as

American citizens. Other preservationists were less explicit, but still made the point that their primary responsibility was to keep Big Pine Key in its natural state "with its woods, and with its pine uplands" (Lauren, I12, U16).

Employees of the USFWS tended to share the preservationist focus on social responsibility, even at the expense of individual freedoms. One biologist stated "we've probably passed the point where we can really manage deer, they do what they wanna do and they leave the refuge. But that does not mean we shouldn't try to get a hold of every possible piece of land that we have" (John, I2, U6). Another biologist evinced a less rigid view toward specific policies by saying that, historically, an extreme situation required an extreme stance, but now that the refuge had acquired most of the "good" habitat they could "lower their guard" (Tevis, I17, R25). Despite the variation in views regarding specific policies, however, the emphasis on social responsibility never wavered.

Although the Key deer themselves were often blamed by the media for the conflict, all informants indicated that either property rights or stewardship for nature was at the crux of the conflict. Preservationists stated that the PPRAs were fighting to destroy nature, and cited greed (e.g., the desire to make as much financial profit from nature as possible) as the true motivation rather than reverence for property rights. Conversely, PPRAs argued that preservationists were fighting to destroy human development, and they maintained that greed (e.g., the desire to have the federal government purchase and control property for preservationists' personal benefit), as opposed to the responsibility of living in harmony with nature, was the true motivation

for preservationists. In addition to accusing each other of misusing individual rights, both cultures saw the other as an arrogant proponent of a distorted sense of social responsibility. Preservationists claimed that PPRAs ignored their responsibility to humans who lived outside of the temporal and spatial confines of Big Pine Key, and PPRAs claimed that preservationists ignored their responsibility to fellow residents of the key. Both sides saw the deer as merely a pawn of the opposition.

On Big Pine Key, moral cultures that defined right and wrong enabled exemplars of the 2 distinct moral cultures that typify environmental conflict in the United States, PPRAs and preservationists, to evolve. From the perspective of PPRAs, environmental policies that enhance individuals' abilities to maintain private property are right, while those that limit private property rights are wrong. Similarly, for preservationists, environmental policies that encourage socially responsible behaviors are right, while those that privilege individuals over society are wrong. As discussed in the introduction, both perspectives toward the environment are quintessentially American in their political activism, and both claim that our very humanity requires holding firmly to the values they espouse.

**Opposing Aspirations**

Cultural differences between PPRAs and preservationists promoted incompatible aspirations. Those informed by PPRA perspectives wanted all property owners free to build, remodel, or otherwise alter their property unhindered by regulatory restrictions. They also advocated development, growth, and respect for individuals' property rights. Various informants described parks, a new elementary school, new housing in existing

subdivisions, infrastructure including expansion or paving of roads, and remodeling and/or expansion of existing businesses as illustrations of the development they sought. They also aspired to unfettered use of private houses and their grounds, including no interference from the community when they chose to remodel a building or build a fence. For example, in an April 1992 Key deer news broadcast, 1 citizen said "fencing should be allowed anywhere a man owns a piece of property to protect his property and his children and his home." Another couple stated, "to grow anything around here, we have to fence it all in, and yet they won't let us fence our yard, not that I would." They added that even with the new regulations allowing fencing, you must leave "5 feet on the side and 10 or 15 on the road. When you have a 60 by 80 lot you're losing an awful lot" (Scott, I4, U4). Whether or not individuals were allowed to do as they wished with their property was not the fundamental problem. Rather, the very idea that they were required to ask permission was wrong. Another informant said "I want to put a storage shed on my [commercial] property" and "I shouldn't have to go begging hat in hand to Fish and Wildlife every time I need to do something on my property" (Shayne, I3, U19). Although several PPRA informants claimed to oppose unfettered development, particularly commercialization, they indicated that because of their reverence for private property, they had to allow all property owners the freedom to do as they wished with their property.

Not surprisingly, preservationists felt directly responsible for ensuring that all remaining undeveloped land was purchased and preserved in its natural state in perpetuity. The Key Deer Protection Alliance, the Big Pine Key Civic Association, and

sometimes the NKDR, depending on perspectives of managers at the time, supported this stance. Representatives of the Key Deer Protection Alliance, the local watchdog group for the deer, indicated their primary concerns were preservation of land and reclamation of natural habitat—not preservation of deer (Celina, I1, U17). Representatives of the Big Pine Key Civic Association flatly stated that their primary goal was "no more development on Big Pine Key" (Robert, I15, U10).

Discussions with refuge employees, as well as their public statements, indicated that, at least historically, the refuge personnel's primary aspiration was to acquire and preserve more land rather than use other management options, such as habitat reclamation or captive breeding. A previous refuge manager said, "If we don't have habitat nothing else matters. We need more land. The deer are using everything that's left" (Straw 1998:28). This attitude began changing as new population estimates indicated the deer were thriving, but it was pervasive in refuge history and is still advocated by refuge personnel.

The differing aspirations of PPRAs and preservationists regarding land use were rigidly tied to their respective moral cultures—essentially ruling out compromise. Informants indicated that yielding on even 1 issue was unacceptable because it would represent conceding the moral ground underpinning their stance. This phenomenon typically was perceived through the opening-the-floodgates metaphor. Many PPRAs indicated via interviews, newspaper articles, and personal correspondence that allowing preservationists to prevent a single person from exercising his/her constitutional right to unfettered use of property would eventually allow the USFWS to seize all personal

freedoms. Further, Overbeck (1999:3), writing for the *Lower Keys Barometer*, argued that "everyone understands when your neighbor loses a right you also lose that right. It may take a little while for you to feel it, but feel it you shall!" Similarly, preservationists felt that their failure to oppose PPRA attempts to build anything would open the door to full-scale development on Big Pine Key (Celina, I1, U30; John, I2, U10; Robert, I15, U8).

Moral culture predisposed the community to address this conflict in particular ways. Although both cultures commonly used avoidance strategies, occasionally avoidance magnified the perceived problem until the avoiding party engaged in contention. Neither PPRAs nor preservationists saw any possibility for common ground, so collaboration was not an option. When asked if any common ground existed between the factions, a preservationist informant responded that he could not think of any because the other faction denigrated his group in the newspapers and they were "fighting it out" over incorporation (Trenton, I16, U20). A refuge biologist stated that parties rarely sought out the middle ground because they have "that gang mentality, almost" (John, I2, U15). When asked whether various interest groups on Big Pine Key shared any goals, a preservationist representing the Big Pine Key Civic Association said, "at the present time, I don't see any common ground" (Robert, I15, U12). The cultural component exacerbated this conflict in its initial stages because culture influenced both the rigidity of aspirations and perceived common ground, which in turn influenced how disputants chose to address the conflict.

In sum, a review of all available data, including interviews, field notes, public meetings, personal communications, media, and technical reports indicated that this dispute centered in land use as opposed to the Key deer. Both cultures repeatedly accused the opposition of using the Key deer as a pawn in their schemes to control land use. Additionally, participants from both cultures admitted to doing the same, although they explained that their own strategic use of the deer was necessitated by the opposing culture's behaviors. Lastly, proponents of both perspectives felt that yielding on a single point, however trivial, was contraindicated because it represented conceding moral ground.

**Escalation**

The opposing aspirations of PPRAs and preservationists led to escalation, which functioned both as an unwitting response and as a political strategy. Political activism, or the belief that individuals are responsible for participating in their own governance, contributed to further escalation of this conflict. Positive attitudes toward political activism in the United States date at least to the *Declaration of Independence* (Kraus 1959), which states that, when faced with "abuses and usurpations, pursuing … a design to reduce them under absolute Despotism, it is their [the people's] right, it is their duty, to throw off such Government, and to provide new Guards for their future security." Although residents of Big Pine Key were no more likely than other Americans to be able to quote this precise language, they respected those who dutifully attempted to influence governance. Although preservationists and PPRAs were focused on social responsibility and individual freedom, respectively, both believed in political activism. Therefore, both

factions created or co-opted formal organizations as mouthpieces. The Key Deer Protection Alliance and Big Pine Key Civic Association spoke for preservationists, while the Chamber of Commerce and *Lower Keys Barometer* represented PPRAs. Because both cultures in conflict were morally grounded, even the earliest stages of escalation closed off possibilities for negotiation and resolution and at the same time mitigated against the possibility that conflict might subside relatively quickly. Instead, value differences led to structural changes that perpetuated, and further escalated, the conflict.

*Mystification*.—The first step towards these structural changes was the development of fear and confusion by mystifying the competing moral cultures. Both moral cultures identified those informed by the opposing culture as enigmas, maintaining that the opposing culture's rationale was unknowable by reasonable humans. One informant explained that it was impossible to cooperate with members of the opposing culture because, "there is no shared value system in this community" (Celina, I1, U23). The human tendency to fear the unknown thrives in such situations. Further, because neither party could be expected to understand the values espoused by the other, any attempt to do so was deemed irrational. Any engagement between the 2 led to anger, because ignorance of the other's cultural norms led members of both groups to say and do things that aroused hostility from the opposition. Thus, the moral authority of each culture was simultaneously the norm most flagrantly violated by members of the other culture and the norm most invisible to its adherents, because it

provided adherents with their ideological foundation, which could not be challenged without endangering fundamental cultural tenets.

Organizations that disseminated the PPRA message repeatedly blamed preservationists for giving deer more rights than humans, and "making the children feel that the deer are more important than they are" (Ed, I19, U41). They failed to consider that a basic cultural norm within preservationist culture was that an action was wrong if it either violated the stewardship responsibility humans have for nature or limited opportunities for society, including posterity, to experience nature. Conversely, preservationists expressed anger and frustration regarding PPRAs' support for a chain restaurant on Big Pine Key, because "we all moved here for the rural atmosphere" (Trenton, I16, U13). The preservationists were unaware that, for PPRAs, denying current landowners the right to sell their property to the restaurant chain was akin to denying democracy, freedom, and even humanity. Because fear and anger exacerbated negative images and attitudes between the groups, members began to deindividualize, dehumanize, and even demonize the opposition.

*Deindividualization*.—Individually, most residents of Big Pine Key held relatively moderate views. The vast majority wanted the island to retain its rural character and be "spruced up a bit" (Field Notes). The latter referred to some combination of repairing worn down businesses and signs, eliminating unsightly exotic vegetation, alleviating traffic problems through some type of road alterations, and allowing some number of new houses to be built on gravel lots in existing subdivisions. For example, several members of the Chamber of Commerce stated they did not want

new commercial development or housing built on lots covered with native vegetation and claimed to value the land on Big Pine Key for its aesthetic beauty. Similarly, several members of the Key Deer Protection Alliance and the Big Pine Key Civic Association supported improving roads, regretted blocking an elementary school on Big Pine Key, and voiced no disapproval of homes being built on scarified lots within existing subdivisions.

Although values certainly were instantiated in individual people, they developed within social and cultural contexts. So, although many individuals held more moderate views than either moral culture, they sought a voice and identity within existing cultural groups. Those with the most extreme incompatibilities tended to both recognize and address conflicts first, thereby framing the situation for other participants. For example, a recent dispute addressed incorporation of Big Pine Key. Those who first addressed this issue held extreme viewpoints even within their own moral cultures. The PPRA extremists likened themselves to the American colonists under British control because they lacked representation. They claimed that under the current regime, a corrupt government was denying them the free exercise of their rights. Preservationist extremists described the proposed incorporation as a scheme for the Chamber of Commerce to control the island (Joseph, I8, U31). Initially more moderate adherents of each cultural perspective failed to see incorporation as either a panacea or bane for the community. By the end of the study, however, these informants were so infuriated by the tactics and statements of the opposition that their initially moderate stances were forgotten. One preservationist stated that he could not think of any possible common ground with

PPRAs because he was so involved in fighting incorporation and the opposition was "calling us liars and everything in the papers" (Trenton, I16, U20).

This highly polarized environment allowed no voice or group identity for those who felt strongly about the conflict, but held more moderate views. They were either forced into silence or into 1 of the polarized moral cultures. Those who were unwilling to embrace an existing moral culture and its attendant social norms felt their participation only added to the problem and were resigned to nonparticipation. Conversely, if they felt strongly enough about the issue to forgo silence, they were forced to join 1 of the existing moral cultures. Further, those who did participate became resigned to the degraded forms of communication typically used by the culture with which they aligned themselves. One couple stated that when they moved to the community they felt the County was bent on developing Big Pine Key to the maximum limit, which would hurt the community. Initially, they were not against siting the elementary school on Big Pine Key. They fought it, however, because they learned from other participants that "schools are always a magnet for growth" (Robert, I15, U23). So, they "more or less joined the environmental group in fighting any development here." Similarly, an influential community member told me the story of his forced entry into the developer faction (Ed, I19, U48). When he moved to the community he tried to promote a local elementary school. He stated that the minute he opened his mouth he made instant enemies and was labeled a pawn of developers and contractors. He summed up his interview by saying, "when I first came here I thought I could help. I jumped into the water and made a big splash, but I got out fast." Thus, the more

moderate voices were either forcibly assimilated into the existing moral cultures or silenced.

The process of moving toward extremes was facilitated as each group deindividualized members of the opposition by giving them denigrating labels. The PPRAs shared a common idea that the preservationists consisted of hypocritical "got-miners," people who "came here from somewhere else, who have decided, you know, 'I've got mine and nobody else can have any more'" (Wayne, I6, U5). They shared the common story that the opposition was composed of outsiders who made their fortune exploiting nature in other places, and then came to Big Pine Key where they tried to prevent locals from reaping the same benefits from their property that got-miners had elsewhere. The PPRAs maintained that preservationists had houses, canals, and fences, but lobbied the refuge to take the right to have these same things away from everyone else. In sum, PPRAs believed the opposition was hypocritical, and it refused to discuss issues in public meetings and forums—preferring to secretly pressure government organizations to carry out their nefarious schemes to defraud private property owners.

The PPRAs also designated a group identity, formed through shared stories, about "The Refuge," which includes past, present, and even future employees. Ruth, a PPRA informant clarified the temporal stability of this identity. After blaming a past refuge manager for current problems she said, "I like him [the current refuge manager] but I won't trust him because The Refuge just cannot be trusted (Field Notes). A favorite PPRA tale is the story of The Refuge forcing the owners of the Coconut Farm Nursery to move because they could not remove their fence without allowing the deer to ravage

their plants. The Refuge's evil intent was substantiated by claims that it had then attempted to prevent the nursery from relocating on U.S. Highway 1, until the ensuing "public uproar" forced The Refuge to back down. Finally, although The Refuge used the fence as an "excuse" to destroy the value of someone's private property, refuge employees left their own fence in place until >5 years of "whacking" by the community finally pressured them to pull it down (Dave, I14, U22). The Coconut Farm story also spawned several other tales, including those of unpermitted housing proliferating on USFWS property at the same time private owners had to go through an onerous permitting process before being allowed to make even the slightest change on their own property (Dave, I14, U22; Tiffany, I4, U28). Other stories vilifying The Refuge also proliferated. According to the reality constructed within this moral culture, evil biologists prevented grandmothers from fixing treacherous driveways because a single rabbit pellet was found near the property (Field Notes). In this story, the grandmother kept domestic rabbits, but biologists automatically assumed the pellet came from an endangered Lower Keys marsh rabbit. In other stories, The Refuge engaged in conspiracies with preservationists to force honest, hard working families out of business and into bankruptcy (Wayne, I6, U3; Dave I14, U22). One informant reported that a refuge employee had attempted to persuade an unwilling seller by threatening that, "when we do our controlled fires, if your house gets on fire, there won't be anybody to put it out" (Ruth, I10, U38).

Preservationists held a no less demeaning view of refuge personnel than the PPRAs. They shared the PPRA proclivity to refer to USFWS personnel as The Refuge.

For example, one said “The Refuge” had failed to fulfill its mandate to protect endangered species habitat, “and I see them signing off on stuff they shouldn’t be signing off on” (Celina, I1, U33). She further opined, “I have found them to be quite castrated in their decision making.” The preservationists also shared a set of stories that deindividualized the PPRAs. Preservationist stories tend to characterize PPRAs as foolish at best, and criminal at worst. Attempting to work with such people was useless, or at least extremely difficult, due to their lack of education and ignorance. One informant explained PPRAs as people with “blighted aspirations,” “narrow information sources,” and limited experiential and educational backgrounds (Eric, I1, U22). Another described PPRAs as having “less money, living from day to day, and with lower education levels.” She went on to say, “few of them even have bachelor’s degrees, I don’t see there is any way to get through to them” (Lauren, I12, U15). One story of erratic behavior attributed to PPRAs tells of a Methodist minister who, after kicking the Big Pine Key Civic Association out of the church’s meeting hall for an ostensible schism in basic beliefs, “started a commune in Tennessee, believe it or not, and took 15 or 16 people from Big Pine with him” (Trenton, I16, U34). Not only were PPRAs labeled as ignorant and eccentric, but also as dangerous. When explaining why reasonable people would choose to avoid interacting with PPRAs, a member of the Big Pine Key Civic Association compared realtors and the Chamber of Commerce—surrogates for individual PPRAs—to drug-dealing fishermen who exploited the environment and the law to get rich, saying “it’s like that with vacation rentals. We got an ordinance passed to prevent them, but they just do it illegally, they have no respect for the law” (Erin, I15,

U37). Preservationists commonly used the label "concrete coalition" to denigrate PPRAs. One informant claimed that, "the concrete coalition would like to see the Keys become the ultimate tourist attraction and everything here paved and Disneyfied" (Josh, I13, U17).

*Demonization*.—Because humans tend to empathize with other individuals (Rubin et al. 1994:82–97), deindividualization clears a path toward demonizing the opposition. The nature of each group's moral culture also encouraged this transformation. Preservationists saw those who ignored their stewardship and social responsibility by harming the environment as degraded and arguably less than human, while PPRAs saw those who relinquished, or attempted to take property rights, in the same light. Both groups were fully aware that they had been christened with pejorative labels. One PPRA couple explained that, according to preservationists, "we're the Darth Vader, we're the evil, they call us the greed-meisters" (Tiffany, I4, U45). A preservationist informant said simply, "they call us the got-miners" (Trenton, I16, U7). Because individuals had lost their identities and been dehumanized through group labeling, opportunities for conflict escalation proliferated, and possibilities for cooperative relationships between the moral cultures were precluded. Further, once the opposition lost its human identity, only a small transformation was needed to perceive them as evil incarnate.

Demonization of the opposition, the most extreme stage of conflict escalation, was evident in local churches, schools, and civic organizations. When attending a church service in the area, the research team's ethnographer was asked his vocation. The fact

that he was a wildlife ecology student interested in Key deer evinced 2 equally strong, but disparate responses—1 approving and the other immediate distrust. Soon after moving to the area, a woman affiliated with the refuge attended a local church and was transfixed by a congregation of cold stares after announcing her affiliation. She asked, "what?" and an elderly woman beside her whispered, "people here don't like The Refuge" (Field Notes). Other refuge employees cautioned their spouses and children not to indicate affiliation with the refuge in school or civic groups. Others sent their children to private schools on other islands.

Several informants compared The Refuge to the Third Reich. One, describing a refuge manager's entrance into a meeting, said, "he marched into our meeting like Hitler" (Scott, I, U136). Another said "he came here and turned it into Nazi Germany, it was a war between The Refuge and the people" (Dave, I14, U28). An article in the *Lower Keys Barometer* tells of a woman whom USFWS officials drove from her home while her daughter was dying of cancer (Anonymous 1995). Similarly, a PPRA described past attempts to communicate with the preservationists in these words, "It's like those religious wars, I understand you don't believe in what I believe so you're a piece of shit and I'm going to have to kill you" (Wayne, I6, U6).

Although both sides demonized the other, the language of demonization was most prevalent in PPRA discourse. This may have occurred because of the current legal climate, where court interpretations of the ESA appeared to favor the preservationist agenda. Clearly, the PPRAs felt their moral authority was constantly violated during the last decade, and they held preservationists responsible. Conversely, preservationists

feared that, since their moral authority had been violated previously, they had to maintain constant vigilance to prevent a recurrence of past evils. They viewed strict implementation of current development restrictions on Big Pine Key as the primary means of ensuring appropriate stewardship of nature. Accordingly, preservationists typically held local PPRAs responsible only for attempted evil. If, however, the situation reverses (e.g., the Key deer is down-listed or the building moratorium is lifted), this dynamic easily could reverse. Interestingly, as unlikely as this seemed during the study, the Key deer is now under consideration for down-listing (E. Hoyle, NKDR, personal communication).

**Reinforcing Mechanisms**

*Selective Perception and Judgment*.—Negative images of the opposition produced by deindividualization and demonization promoted several mechanisms that reinforced hostilities. One of these was selective perception and judgment. Combatants typically observed only those facts that confirmed their negative image of the opposition and were suspicious of anything the other party did regardless of its innocence. For example, recently revised estimates of Key deer numbers were supported by the PPRAs. Conversely, preservationists automatically assumed that PPRAs only supported the new estimates because they were much higher than previously and might allow down-listing of the deer, or at least increased development (Robert, I15, U2). The preservationists rationalized away increased Key deer abundance by assuming that the new estimate was "just a cyclic boom and bust situation" (Eric, I1, U3; Robert, I15, U2). Further, they worried that PPRAs and refuge personnel would collude to allow destruction of deer

habitat based on “just a snapshot” in time (Celina, I1, U7). The PPRAs, on the other hand, believed the preservationists concocted this supposition in order to hide their true motive—“locking up other people’s property on the island”—when faced with a higher estimate than previously used to deny individuals their property rights (Field Notes). Both groups indicated that the refuge was buying into the opposition’s viewpoint. In sum, neither group saw even an inkling of sincerity in the opposition’s perspective.

Actions were taken, however, for which neither group wanted to publicly accept responsibility. Several preservationists indicated that the recent decapitation of a Key deer (31 March 2000) was the result of angry PPRAs (Field Notes). The Key Deer Protection Alliance offered a $1,000 reward for information leading to the arrest of the person responsible for beheading the young buck. Conversely, the PPRAs downplayed the incident. They claimed that it “was probably a prank, whether it was done by juvenile kids or adult kids, it was kid’s stuff” (Wayne, I6, U4). Mutual suspicion ran rampant. A preservationist summed up the situation in these words: “There is no time for the positive stuff, you have to spend all of your time catching them in their tricks” (Celina, I1, U28). A PPRA described it this way, “Even when it would behoove them to tell the truth they don’t” (Jared, I9, U5).

*Moral Exclusion and Rationalization*.—Another reinforcing mechanism at work in the conflict was moral exclusion and rationalization. This process permitted combatants to deny the protection of their own ethical system to others and, in its extreme, allowed them to commit emotional and even physical violence without considering it morally wrong. In fact, violence seemed to be the morally favored action.

Emotional violence was common. One preservationist told about staffing a booth for his organization at Key West and having a PPRA scream obscenities at him and his wife while the PPRA's children looked on (Trenton, I16, U21). "Animal Sacrifices," an article in the 30 April 1988 *Keynoter*, blamed animosity towards the deer on "ignorance and neglect" (Harder 1988). The PPRAs who participated in my study expressed considerable anger, frustration, and resentment when they were labeled "ignorant and uneducated" (Field Notes).

On occasion, emotional violence flared into threats and even physical violence. Someone decapitated a buck, and then threw the head over the refuge maintenance facility fence (14 April 2000). A checker at the local grocery store told me she hoped the person responsible for beheading the deer would be caught, because "that person should be taken out and shot" (Field Notes). Although PPRAs were quick to distance themselves from this act, 1 informant explained that the decapitation incident indicated how volatile the relationship between the 2 cultures was, stating that threats of physical violence, either toward humans or deer, were "idle talk 99.99% of the time except for, someday, people are going to piss off the wrong person" (Wayne, I6, U4). When a local reporter from the PPRA perspective attended a Big Pine Key Civic Association meeting with a microphone and preceded to ask questions, a member spotted the device and yelled, "he's got a microphone and a tape recorder" (Jared, I9, U6). The president of the Big Pine Key Civic Association reportedly grabbed the device, broke it, and told the reporter, "get out of here. This is a private meeting."

Both sides used these flare-ups to rationalize further demonization of the opposition. For example, preservationists emphasized the violent behaviors of PPRAs, who they accused of bludgeoning a doe to death with a club (12 August 1990). Although those convicted of the crime were not from Big Pine Key, on the anniversary of the bludgeoning, someone hung a dead doe from a road sign that listed the number of deer killed on the highway (12 August 1991). The sign, which was intended to slow traffic through Big Pine Key, became a focal point for violence fostered by the mechanisms of moral exclusion and rationalization.

*Communication Breakdown and Autistic Hostility.*—The anger and hurt resulting from these emotionally and physically violent episodes led to a reinforcing mechanism that virtually ensured perpetuation of the conflict and more violence—the breakdown of communication into autistic hostility. Numerous informants from both sides of the conflict told of failed attempts to communicate with the opposition. A PPRA from the Chamber of Commerce described his attempt in these words: "You walk out of there so angry, so frustrated. Your blood pressure is sky high because you'd like to strangle them. They're so stupid and pig headed" (Tiffany, I4, U119). A past president of the Chamber of Commerce told of an attempt to bring the opposing factions and the refuge personnel together to work on a common project. He had hoped to find "something, anything, just something where we could put our differences aside and work together" (Wayne, I6, U3). His peers perceived his behavior as a breech of trust or "getting in bed with the enemy." Nothing came from the project, and he was left with the impression that attempting to work together was futile. A preservationist from the Key Deer

Protection Alliance described a protracted series of conversations she had with a PPRA. She had believed they were beginning to understand each other's perspectives. She was disillusioned, however, when her PPRA acquaintance reverted to form by becoming enraged at "The Refuge" for buying "prime real estate" for parkland (Celina, I1, U30). A Big Pine Key Civic Association informant described the school siting mediation process as a "battle" in which there was never a "meeting of the minds," so "the process just fell apart" (Robert, I15, U26). He learned from the Big Pine Focal Point Plan that regardless of the amount of discussion, no one changed theories or ideas, so he quit wasting his time trying to work with the opposing faction. Another preservationist informant used the attempt to site a school on Big Pine Key to illustrate the total futility of attempting to build a shared vision between the opposing cultures (Trenton, I16, U15). "We couldn't cooperate on the children," he explained. "They wanted to build a school on Big Pine and we had to fight over that." Moderation was either attenuated or lost as individuals engaged the opposition within the organizational framework of their moral culture.

All my informants' efforts to work with the opposition ended in frustration and anger at the opposition's intractability, or confusion regarding their values. Similarly, a refuge employee told of how he once attempted to work with both sides, but saw people "sugarcoating" issues, and telling him 1 thing on the spot, and then reverting back to their original views right after the meeting (John, I2, U15). For example, he said that the only benefit of making presentations to PPRAs was getting "warm fuzzy feelings, but ... was it worth the controversy?" This breakdown in communication also was evident in public venues. For example, public meetings regarding the Big Pine Focal Point Plan,

siting an elementary school on Big Pine Key, and a USFWS question-and-answer session all turned into a series of inflammatory stump speeches where speakers relinquished the microphone to applause and yells of approval or boos and accusations of lying (WWUS 1989, 1992).

There can be no doubt that this communication breakdown led to autistic hostility. For example, although those who were actively involved in the conflict indicated several means used to achieve their goals, none of these included attempts to communicate with the opposition. A PPRA informant indicated that working together on anything was like "designing a horse by committee" and "the best you can hope for is a plan that everybody is aggravated about" (Shayne, I3, U24). Another PPRA said, "now my basic approach is to stay out of the politics of the Keys" (Ed, I19, U41). When asked how best to manage the conflict, a preservationist said, "the classic answer is to work together, but it's better to let TNC [The Nature Conservancy] and USFWS buy up all the land" (Josh, I13, U18). A refuge biologist indicated that bringing people together to work on a solution would only lead to compromise and loss of more habitat, whereas "'combat biology' has saved what little is left" (John, I2, U14). Although several informants indicated that some kind of public forum to facilitate communication and understanding between groups might be a good idea, none saw it as even a remote possibility in the current circumstances.

Many participants moved beyond viewing communication across opposing cultures as futile by endeavoring to guard against any possibility of information exchange. In the *Lower Keys Barometer*, Howe (1997:12) stated that he would not share

information with the refuge manager, Barry Stieglitz, because of his "anger at the sickening mix of arrogance and ignorance during the Stuart Marcus, John Andrew regime." Another PPRA said, referring to Jim Halpin, the new refuge manager, "I don't know the fellow and I don't even care to meet him" (Dave, I14, U19). A previous refuge manager made his awareness of this problem known in an interview, stating, "our staff doesn't even like to go to the grocery store, people see the uniform and they give us dirty looks (Straw 1998:29). Halpin, the refuge manager during data collection for this project, faced the same problem. One local realtor reported, "I like him, but I won't trust him, because The Refuge just cannot be trusted" (Field Notes). The practices associated with escalation had contributed to structural changes that further validated disputants negative perceptions of each other. Clearly, finding an amicable solution to a long-term conflict such is this is unlikely when the parties have demonized one another, communication has broken down, and their only interactions are grounded in autistic hostility.

## DISCUSSION

### Moral Culture as Grounding for Environmental Conflict

The days of broad public acceptance of management decisions made by a small technical elite are gone, if they ever existed (Daniels and Walker 2001). Despite claims that Americans have become politically apathetic, U.S. citizens are increasingly demanding an opportunity to participate in decisions regarding the management of the natural environment. Hiding behind impenetrable jargon and regulations only exacerbates the traditional American distrust of, and alienation toward, government—it

does not make the public go away. We recommend that applied ecologists take a proactive approach when faced with an activist public that draws much of its cultural identity from the natural resource in question. There are several approaches that could facilitate public participation in such emotionally charged decision-making venues, including, but not limited to, those that attempt to assist disputants through a focus on community-based collaboration (Dukes et al. 2000, Wondolleck and Yaffee 2000, Daniels and Walker 2001) and sustainability (Maser 1996, Peterson 1997). Increasingly, dispute resolution specialists are recognizing the importance of integrating the strategies and tactics they offer into systematic representations that explicitly recognize the significance of cultural identity (Ashmore et al. 2001, Littlejohn and Domenici 2001, Senecah 2001).

Although determination of the appropriateness of individual approaches, and their application, often includes traditional information-gathering techniques such as opinionnaires, these techniques are not sufficient when faced with conflicts rooted in moral cultures. Although opinionnaires are an effective means for identifying public opinion, they are not as well suited for collecting information on public judgment or motivation to act. Ethnographic methods are more relevant to understanding public judgment and motivation to action. For example, if a manager is interested in identifying the reaction of various publics to a certain policy, an appropriately designed survey instrument will provide excellent information. If, however, one is interested in understanding why competing moral cultures developed, what current differences exist,

and how to establish meaningful dialogue and collaboration across cultures, ethnography is a more appropriate tool.

Because many environmental conflicts have cultural dimensions, environmental policy makers and managers should familiarize themselves with the literature on cultural conflict. Although most research on this topic focuses on disputes among nations or ethnic groups, concepts drawn from this arena could enhance the management of many environmental conflicts, especially those associated with endangered species. As illustrated in this case study, the concept of endangerment, as opposed to extinction, is a social and political construct. Although biological information may be used by all conflict participants, simply ensuring that all parties have access to the same information does not ensure that they will necessarily come to the same conclusions. In disputes over endangered species management, the idea of limits comes into play, and with it, fundamental questions of cultural identity. Participants find themselves making decisions with consequences that extend beyond the individual's space and time. In such a social environment, members of any society turn to cultural norms for answers. Thus, in a society where public participation and technical expertise vie for precedence, cultural conflicts such as that developing on Big Pine Key should be expected to occur more, rather than less, often.

**Conflict Development on Big Pine Key**

Moral cultures on Big Pine Key developed from a multidimensional matrix of values, within which individual values had different saliency for different individuals and in different situations. Despite individual differences, however, participants derived

guidance for action from their moral culture. They often joined groups that promoted extreme stances, then turned over responsibility for individual knowledge, beliefs, and actions to the group. Regardless of its veracity, the salience of any information was determined by its acceptance within their moral culture. Although informants did not question the veracity of their own cultural premises, most rejected that of the opposing culture's premises. While no informants indicated their individual participation in the conflict was based on selfish motives, most believed participation by members of the opposing culture was. From an observer's perspective, there is no question that certain community members simply used the conflict to further personal interests. Some fought to preserve habitat for the sole purpose of preserving empty lots that enabled a sunset view from their homes. Others fought to protect individual freedoms only to further their individual business interests. These motivations did not, however, deflect the power of the competing moral cultures on Big Pine Key. The moral authority behind these cultures justified participants' hostility toward those who stood in their way, whether or not individual actors accepted that moral authority. It provided an entire system of shared beliefs, stories, and actions that led to a political impasse.

The Big Pine Key land-use conflict has moved through the same general phases as have most other cultural conflicts. Initially, the conflict was grounded in a deeply ingrained cultural divide between those who believed in the sanctity of individual freedoms and those who believed in the sanctity of community responsibility. With no management attention focused on these fundamental beliefs, the cultural divide expanded, furthering the division between the aspirations of both groups. Those whose

moral culture focused on protecting individual freedom became advocates of private property rights at all costs, while those whose moral culture focused on the responsibility of public stewardship became advocates of preserving natural habitat at all costs. Not surprisingly, these conflicting aspirations led to conflict escalation. I traced the conflict's escalation through the stages of mystification, deindividualization, and demonization of the opposition. Once the conflict had escalated, participants reinforced its intractability by engaging in selective perception and judgment, moral exclusion and rationalization, and finally communication broke down completely, leading to autistic hostility. Further, those who disagreed with the extreme stands of the 2 opposing moral cultures were either forcibly assimilated or silenced.

**Appropriate Role of Resource Management Agencies**

Following repeated negative experiences with the public, local USFWS personnel commonly have offered passive neutrality as a management option (Field Notes). This term suggests managing the conflict by staying out of it and simply going about federally mandated business in a neutral fashion. Again, this is not an option when conflicts are rooted in moral cultures, such as that surrounding Key deer. First, it blinds refuge personnel to both the escalation of the conflict and its causes. One refuge manager told us, "This is national, it's more than local, the rules that are in place fit everyone, the guy that lives in Oklahoma City has as big a stake in this refuge as the people down here" (Rick, I7, U19). This one-size-fits-all view ignores the moral and cultural roots of the conflict, and prevents their remediation. It follows that little can be done to resolve a conflict if its fundamental cause is not addressed or even

acknowledged. The passive neutrality approach also assumes that refuge managers and employees can maintain a neutral stance amid a barrage of criticism in perpetuity. Whether such neutrality on the part of any human is theoretically possible is a philosophical question that is beyond the scope of this study. Practically speaking, however, it has not occurred. Finally, this approach ignores the fact that moral cultures create unwilling bedfellows. A refuge manager stated "as far as getting into the community and affecting the life of the community while sitting in this chair, I don't have friends and enemies in different groups" (Rick, I7, U14). His belief in the veracity of his statement, however, was not shared by community members. Nearly everyone else described the refuge manager either as a "friend" saving a rural way of life and protecting nature, or as an "enemy" forcefully denying property rights (Field Notes). The closest any came to describing the manager as neutral was a small number who described him as a foolish pawn of the opposing cultural group. Despite claims to the contrary, agencies tend to exhibit both a generalizable bureaucratic perspective, as well as a perspective tied to their own mandates. Researchers have identified strong cultures within agencies charged with management of natural resources (Bullis and Tompkins 1989, Sherblom et al. 2002). Although my data are insufficient to support a claim that the USFWS represents a third moral culture in conflict on Big Pine Key, they do suggest that management by passive neutrality is a dysfunctional myth.

*Limitations of Past Interventions*.—The Key deer section of the 1999 South Florida Multi-species Recovery Plan concluded with the following objective: "Increase public awareness of Key deer habitat and instill stewardship" (USFWS 1999:4–24). The

report suggested 3 means for achieving the plan's objectives. The USFWS was to conduct educational workshops, encourage specific behaviors among private landowners, and prepare informative literature. Similar suggestions were voiced in a 1992 USFWS upper level management training report (Faanes 1992). Faanes (1992) suggested joining community service organizations, conducting town hall meetings on the role of the USFWS and National Wildlife Refuges in the Keys, submitting regular newspaper columns, and creating priorities and direction for refuge biology.

Although all of these recommendations could be helpful if implemented as part of a systemically designed conflict management strategy, they are unlikely to significantly reduce current problems—they do not address the cultural nature of the conflict. For example, in response to these recommendations, between 1992 and 1997, refuge employees attempted to join community service organizations. Given no establishment of negotiation preconditions, it should have surprised no one that refuge employees were refused membership in the Rotary Club or that their presence at a Chamber of Commerce meeting led to a dramatic split, with several past members leaving the Chamber, and the president accused of "getting in bed with the enemy" (Wayne, I6, U3). One informant told us that, when the refuge manager introduced himself and his organization, "he looked like he was wearing a Nazi uniform" and he "made it plain that his only concern was the deer" (Tiffany, I4, R136). The escalated condition of the conflict precluded a more moderate response to anyone affiliated with the refuge. Acknowledging the escalated condition of the conflict and attempting to

remove the reinforcing mechanisms prior to this action could have prevented such a setback in community relations.

The refuge also attempted to use newspaper columns to defend itself against accusations of lying, deception, and corruption made in the *Lower Keys Barometer*. Unfortunately, these articles further escalated the conflict. A 6 March 1996 refuge article in the *Florida Keys Keynoter* accused critics of holding erroneous beliefs based in a dearth of factual material (Stieglitz 1996). Rather than defusing the conflict, this article elicited further angry responses in the *Barometer*. In the 28 March 1996 issue, 1 resident called the refuge manager the "new boy," accused him of dishonesty, and challenged him to a public debate (Hunt 1996:15). In the same issue another resident wrote that, "it is about time that we get something for our money, other than being told to stay the hell out" (Monti 1996:7). On 4 April 1996, Overbeck (1996:13) wrote an article accusing "greenie whackos, teamed with the great and wonderful USFWS" of preventing road improvements, and indirectly of causing the conflict within the community. Eventually (23 January 1997), the refuge manager wrote an article for the *Barometer* entitled, "From the Other Side," where he attempted to "set the record straight" and suggested that "armchair wildlife managers" allow "trained experts to do their job" (Stieglitz 1997:6). He concluded with an ultimatum: "our future relations will weigh heavily upon your willingness to rectify these deficiencies" (Stieglitz 1997:6).

As one might imagine, these uses of the media did not successfully ameliorate the conflict. In fact, they simply provided a reinforcing mechanism for further alienation across the existing cultural divide. Residents responded to the manager's attempt to "set

the record straight," by demonizing him, and by association, all USFWS personnel. One wrote, in reference to the USFWS manager, "his daddy is sure to be especially proud of his son for following in his foot-steps as a game manager/bureaucrat. (You know… as opposed to being a real 'game manager' who actually manages wild game.)" (Hunt 1997:3). He also accused the manager of dishonesty, and asked him to "stop pandering to environmental extremists" (3) Another claimed that USFWS personnel were "all potential Oliver North types if we let them" (Howe 1997:13).

Admittedly, the USFWS could have used the news media more effectively, merely by demonstrating a more respectful attitude toward residents of Big Pine Key. But using the media to best advantage would have required a knowledge, and acknowledgement, of the moral cultures involved in the dispute. Sensitivity to symbols and values within the targeted moral culture at very least could have helped avoid hostile responses and allowed refuge critics to read the material in a less defensive manner.

In 1997, the USFWS commissioned another public relations study to evaluate and improve upon the suggestions of the 1992 effort. The final report suggested that public meetings be limited in size, even to the extent of being one-on-one encounters, because large meetings could "easily be hijacked by opponents" (Community Strategies 1997:2). It also suggested rapid response to attacks on the refuge by the USFWS national office, because refuge personnel appeared to be overly defensive when they defended themselves. Part of this strategy was to hold a "big-wigs" meeting between high-level USFWS personnel and the community that was carefully structured to reinforce support for the Refuge Manager (Community Strategies 1997:21). The report

suggested a "barrage" of positive outreach to prevent the need for defensive tactics (Community Strategies 1997:18). It also suggested conducting a new census of the deer herd, creating a wildlife management strategy, creating a land acquisition strategy, and training staff in a new attitude and better communication skills. Although these certainly were positive and in some cases necessary suggestions, they were insufficient. The Key deer conflict was rooted in moral cultures, so management agencies must do more than apply generic image-management techniques if they hope to find solutions. In fact, they cannot correctly interpret the public image they have generated, or how to change it, unless they participate in activities that provide them with a means for learning about the relevant moral cultures.

*Opportunities for Future Interventions*.—None of the recommendations discussed above were wrong. In fact, some undoubtedly could improve the situation. Better biological data and enhanced availability, for example, are good things, but, while it is essential to effective deer management, it does not respond to related (human) social concerns. It is a necessary, but not sufficient part of an effective conflict management strategy. As a case in point, the recently completed Key deer census (Lopez 2001:83-109) alleviated some claims that refuge personnel are lying about population numbers to obtain more funding. The President of the Key Deer Protection Alliance, however, responded to these data by explaining to members in the *Alliance News*, that, "historically the deer population seems to have boomed and crashed cyclically … the planning process for Big Pine and No Name keys must not reflect a complacent attitude toward any of our endangered species" (Putney 2000:3). Biological data do not support

this claim. Clearly, ecological research had surprisingly little bearing on what information was accepted within either the preservationist or PPRA moral culture.

Further, there is little doubt that using a barrage of positive media, instead of waiting for attacks, could make lashing out defensively by refuge employees less likely. Creating a wildlife management strategy, and informing the public about it, also could alleviate some confusion. Similarly, joining community service organizations could promote trust and friendship between the refuge and the community. These suggestions, however, fail to address the crux of the problem—they do not consider the moral cultures of conflicting groups. That is precisely why collaborative decision making further polarized the participants in the school siting mediation process. While such actions might be necessary to deal with a crisis, they cannot move a cultural conflict beyond the reactive mode. Further, because these strategies have legitimized the moral stances of both cultures, the dispute has become increasingly intractable as managers attempt to implement each new strategy.

In sum, natural resource managers must understand and acknowledge the moral cultures of those engaged in conflicts surrounding endangered species management if they hope to help resolve these conflicts. Yaffee (1997:329) argued that much of the failure to resolve natural resource conflicts can be traced to the human preference for addressing superficial problems, while ignoring their "psychological or sociological dynamics." I suggest that modified ethnographic approaches, such as those described in this study, could assist managers in developing this understanding, and eventually, the process skills necessary to help individuals de-demonize, re-humanize, and re-

individualize people from the conflicting moral cultures. To achieve a meaningful resolution to the conflict, the silenced voices must be excavated, which will require the guidance of a skilled facilitator or mediator. Additionally, that person will need to assist disputants in their attempts to begin communicating across the cultural divide. Particularly in the case of long-running conflicts, such as that surrounding the Florida Key deer, I cannot recommend attempting conflict resolution without the guidance of a neutral facilitator or mediator, because all residents, whether actively involved in the conflict or not, were complicit to some degree in its evolution. Until this is accomplished, there is little hope of an amicable solution to longstanding environmental controversies such as that surrounding the Florida Key deer.

**MANAGEMENT IMPLICATIONS**

Given the social context of a pluralistic democracy, agencies responsible for managing natural resources should assist their managers in identifying social practices that typically lead to deindividualization, dehumanization, and demonization. Upon identification of such practices, managers should either intervene directly or seek outside assistance before conflicts escalate. In many cases, early intervention could prevent, or at least minimize, the hostility and violence that has come to characterize endangered species management on Big Pine Key and many other locations across the United States (Lange 1993, Moore 1993, Yaffee 1994, Peterson and Horton 1995). Ideally, the process of preparing natural resource managers to respond more effectively to cultural conflict would include systemic changes ranging from broad education in cultural and conflict theory, to workshops designed to develop process skills needed for conflict assessment

and intervention. In the short-term, agencies might choose to target concepts drawn from the cultural and conflict theory literature that seem particularly appropriate to environmental conflict, some of which were identified in this study. In the longer term, I suggest that agencies should actively support research designed to develop theory and practice specifically directed toward addressing cultural conflicts associated with natural resource policy formation and implementation. Either way, these concepts could then be used to guide the development of skills training for managers.

Successful management of conflicts generally requires that facilitators and mediators have (1) a high level of process skills, (2) an ability to maintain confidentiality, and (3) can demonstrate neutrality regarding the issue under conflict (Purdy and Gray 1994, Daniels and Walker 2001). Managers also must ensure that appropriate conditions exist before attempting to resolve conflicts (Susskind and Cruickshank 1987, Gray 1989, Kolb and Rubin 1989, Senecah 2001). Saunders (1995) recommended that, when working with culturally rooted conflicts, managers must achieve 3 pre-negotiation conditions within all participating moral cultures before attempting to implement mediation or other conflict resolution activities. They must ensure (1) the existence of at least a minimal level of group organization aimed toward negotiation among all potential disputants, (2) a common definition of the problem, and (3) a shared commitment to resolution. Until these conditions are met, there is little point to investing resources in resolution attempts.

Natural resource managers faced with the cultural conflict surrounding Florida Key deer management could begin the process of developing these conditions, even, and

perhaps especially, given the escalated status of the dispute. They should attempt to encourage and facilitate the organization of groups that seek less confrontational approaches by providing easy access to accurate data including biological, sociological, economic, and political aspects of refuge and Key deer habitat management. In many situations, the first step towards this goal is recognizing that natural resource management has more than biological effects. The second condition, a shared definition of the problem related to land management on Big Pine Key, is the condition most tied to moral culture and most difficult to achieve. To achieve this goal, the escalation process must be reversed by developing non-threatening environments within which all parties are encouraged to re-address their aspirations and even to re-examine their moral authority. The security of these environments must be achieved within each moral culture before attempting to bring the 2 groups together.

Productive interactions between opposing groups are unlikely to occur until the reinforcing mechanisms of selective perception and judgment, moral exclusion and rationalization, and breakdown of communication and autistic hostility are replaced by communication practices that remove barriers. As is typical in cultural conflict, the conflicting parties on Big Pine Key previously had little interaction except as they formed their opposing identities through language and story building. This enabled negative reinforcing mechanisms to take effect. To replace these mechanisms, parties must begin interacting in an environment where joint story building and shared language development are not only protected, but encouraged. This can occur through carefully facilitated informal social interactions that help individuals de-demonize, re-humanize,

and re-individualize people from the opposing moral culture. A forum for informal social interaction could be facilitated through interactive problem solving workshops (Kelman 1986). These efforts should not attempt to solve the problem of land management on Big Pine Key. In fact, the topic should not even be discussed. The only topics available for discussion in initial workshops should be those where parties meet the pre-negotiation conditions listed above. Such workshops will require facilitation by third party interveners. Refuge personnel, who are embroiled in the conflict, cannot play the role of neutral facilitator. Providing opportunities for positive social interaction among the cultures of Big Pine Key may be the only initial option available to refuge personnel. After the 3 pre-negotiation conditions are achieved, then the task of finding solutions to the land management issues of Big Pine Key could be addressed using approaches that facilitate public participation in such emotionally charged situations. These include, but are not limited to, those that attempt to assist disputants through a focus on community-based collaboration (Dukes et al. 2000, Wondolleck and Yaffee 2000, Daniels and Walker 2001), sustainability (Maser 1996, Peterson 1997), and other integrated strategies (Ashmore et al. 2001, Littlejohn and Domenici 2001).

Providing a forum for communication that differs from the degraded rhetoric discussed throughout this analysis is 1 way that agency personnel could help all parties meet pre-negotiation conditions. Those individuals who chose silence, because they were unwilling to participate in the degraded rhetorical process, are a primary audience for this forum, although others should not be excluded. For example, an Internet site where accurate biological, sociological, economic, and political data were available and,

more importantly, respectful information could be exchanged among publics, could initially serve this purpose. More formal forums, however, should only be emphasized after pre-negotiation conditions are at least approximated; because premature implementation could push the silenced audience into the cultural divide, thus reinforcing the conflict spiral.

Conflicts such as the dispute over land use on Big Pine Key are difficult, but not impossible, to remediate. Texts gathered throughout this study indicated that both cultures shared a commitment to resolution; even the most extreme informants lamented the days when Big Pine Key was a happy, peaceful community. Granting the possibility that some informants were engaging in unrealistic nostalgia, while others fed on conflict continuation, this generally shared vision offers an opening for agency personnel charged with managing natural resources in the Florida Keys. Further, both federal and state agencies faced with cultural conflicts can take advantage of the commitment to political activism integral in American society. Both the PPRAs and the preservationists shared this moral value and a commitment to conflict resolution. Those who tend to accept the status quo in the name of conservation should consider Yaffee's (1994:360) warning that "as the Reagan and Bush years suggest, it is also important that long-term conservation direction be able to weather shifts of the political winds." These winds are shifting. Due to the current political climate and increased Key deer numbers, it now is likely that the Key deer will be down-listed to threatened. This change is certain to shake up the reinforced structure of the conflict. U.S. Fish and Wildlife Service personnel should take advantage of these changes to initiate positive contacts and encourage re-

humanization of all participants in this cultural conflict. Implementation of these strategies could produce a plan capable of weathering shifts in political power and preserving the community as well as the species.

# CHAPTER VI

# CONCLUSIONS

A systemic approach to Key deer management is needed to address the complex biological, community, and cultural dynamics involved. Population viability analysis modeling is being used to justify proposed management decisions (Lopez 2001), however, the decisions only gain scientific and public legitimacy if the models parameter estimates are realistic. A model based on the previously accepted male-biased FSR with a mean of 2.67:1 (Folk and Klimstra 1991*a*, Hardin et al.1984) does not reflect the population increase observed in the last 30 years (Fig. 2.4, model 7). A male biased FSR of 1.45:1 (a LRC model) best represented the FSR allocation in Key deer. This supports the hypothesis that Key deer can control herd size in the face of fluctuating and patchy food sources (Peterle 1975). Finally, if this is an accurate FSR estimate for Key deer, the population is more resilient to anthropogenic disturbance than previously thought.

Demonstrating respect for individual deer by using capture techniques that yield low mortality and injury rates and quick immobilization indirectly demonstrated respect for individualistic and anthropocentric viewpoints of Big Pine Key community members. This was instrumental to the positive public response to our research. In urban environments, the modified drop net (Lopez et al. 1998), drive net (Silvy et al. 1975), and hand capture might be the most appropriate tools for capturing deer. Although these methods sometimes are more labor intensive, they result in nearly 0% mortality and are perceived favorably by the public.

Careful management and conscientious driving habits of new, human residents on these islands have fostered an interesting relationship between Key deer and development. A concomitant increase in fawn survival and urban development has occurred over the last 30 years. Development and fawn survival, however, cannot be positively correlated after carrying capacity is reached. If every hectare is paved no Key deer can survive. A fulcrum exists where 1 more house will reverse the positive relationship between development and sustainability for the Key deer population.

Understanding the relationships between people is just as important as understanding Key deer ecology and the relationship between deer and humans. Natural resource managers faced with the cultural conflict surrounding Florida Key deer management should acknowledge and respect the importance of these moral cultures. Creating a shared definition of the problem related to land management on Big Pine Key, is the most difficult challenge managers face. To achieve this goal, the conflict escalation process must be reversed by developing non-threatening environments within which all parties are encouraged to re-address their aspirations and even to re-examine their moral authority.

Respecting public perspectives towards Key deer with capture techniques elicited public support for biological research on Big Pine Key. This positive feedback made research efforts more productive which in turn made results of population viability modeling more reliable. This positive feedback generates more public support for management initiatives suggested by model output. Finally, when the cultural perspectives of impacted parties are considered during the implementation process,

intractable conflict can be avoided and more support for management is created. These interactions, however, rely on more than a mere understanding of the system. Effective communication is required for positive feedback to move through the system. Admittedly, no amount of systemic management will allow managers to provide the Key deer enough habitat to remain a viable species and provide humans unfettered land use. Further, unforeseen negative feedback is always a possibility when managing complex systems. Understanding the system will, however, allow managers to respect stakeholder perspectives and cultural norms while addressing these difficult issues.

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