Comparative Study of Sexual Dimorphism in Six Species of Dominican Bats

Devra D. Hunter

Dominica Study Abroad
SCEPTRE, Springfield Estate-West Indies
Dr. Tom Lacher
Dr. Bob Wharton
June 10, 2001

Abstract

Comparisons of weight, and length of forearm, hind foot, and tail between sexes were made for six species of Dominican bats. The project is a continuation of Meghan Kirk's project, Investigating Sexual Dimorphism in Four Species of Dominican Bats. Individuals were sampled from the species *Molossus molossus, Tadarida brasiliensis, Artibeus jamaicensis, Eptesicus fuscus, Pteronotus davyi,* and *Monophyllus plethodon*. Data were also collected for male *Natalus stramineus*. Bats were captured and released on ten nights in seven locations. No overall sexual dimorphism was detected but *Molossus molossus* males showed a larger hind foot than females. Female *Tadarida brasiliensis* exhibited a marginally larger forearm than males of the same species and weighed significantly more.

Introduction

Sexual dimorphism is a comparative difference in size between males and females of the same species. It is common among mammals and can easily be measured and analyzed using statistics. The purpose of this study is to determine if there is any sexual dimorphism and to what degree it occurs. Five families were analyzed: Molossidae (*Molossus molossus, Tadarida brasiliensis*), Phyllostomidae (*Artibeus jamaicensis, Monophyllus plethodon*), Mormoopidae (*Pteronotus davyi*), Vespertilionidae (*Eptesicus fuscus*), and Natalidae (*Natalus stramineus*).

Materials and Methods

To capture bats, six meter Avinet mist nets secured with stakes and rope connected to bamboo poles were used. Nets were set up between 6:00pm and 6:15pm and taken down between 9:00pm and 10:30pm. Bats were collected on the following dates:

1. 5/25/01-Check Hall River, Archbold Tropical Research Center, Springfield
2. 5/27/01- Check Hall River, Archbold Tropical Research Center, Springfield
3. 5/28/01-Bee House-North and West of Pond, Archbold Tropical Research Center, Springfield
4. 5/30/01- Bee House-North and West of Pond, Archbold Tropical Research Center, Springfield
5. 6/1/01- Check Hall River, Archbold Tropical Research Center, Springfield
6. 6/3/01-Fort Shirley, Cabrits National Park
7. 6/4/01- Bee House-North and West of Pond, Archbold Tropical Research Center, Springfield
8. 6/5/01-Rodney's Rock Sea Cave, Mahaut
   Bee House-North and West of Pond, Archbold Tropical Research Center, Springfield
9. 6/6/01-Guest House, Archbold Tropical Research Center, Springfield
10. 6/8/01-Morne Trois Piton National Park, First stream crossing on trail to Middleham Falls near Stinking Hole

Once an individual was caught in the net and removed, the species and sex were determined and measurements taken. If the bat was tangled badly and a legitimate effort made to remove it failed, the net was cut strategically with a knife to prevent undue stress on the animal. If there was not time to process the individual it was placed in a sock secured shut with a clothespin. The weight of the bat (in grams) was measured by subtracting the sock weight from the weight of the bat in the sock. A digital caliper was used to measure forearm, hind foot, and tail length (in mm). Statistix, a Microsoft Windows compatible program was used to tabulate data.

Results

The following codes apply to data in this section:

Species
1=*Molossus molossus*
2=*Tadarida brasiliesis*
3=*Artibeus jamaicensis*
4=*Eptesicus fuscus*
5=*Natalus stramineus*

Sex
1 or M=Male
2 or F=Female

For measurements and calculations
MD=Missing data
ID=Insufficient data

Table 1. Capture Summary

Date	Location	Number of Individuals
5/25/01	**Check Hall River**	**4 M *Molossus molossus*** **10 F *Molossus molossus*** **1 Unknown *Molossus molossus*** **1 F *Sturnira lilium***
5/27/01	**Check Hall River**	**8 *Molossus molossus*** **1 F *Artibeus jamaicensis***
5/28/01	**Bee House-W**	**3 M *Tadarida brasiliensis*** **2 F *Tadarida brasiliensis*** **1 M *Pteronotus davyi***
	Bee House-N	**1 M *Artibeus jamaicensis*** **2 F *Artibeus jamaicensis*** **1 F *Sturnira lilium*** **1 M *Tadarida brasiliensis***
5/30/01	**Bee House-N**	**1 F *Artibeus jamaicensis*** **2 M *Tadarida brasiliensis***
6/1/01	**Check Hall River**	**1 M *Molossus molossus*** **2 F *Molossus molossus*** **1 M *Artibeus jamaicensis*** **2 M *Tadarida brasiliensis***
6/3/01	**Ft. Shirley, Cabrits**	**10 M *Tadarida brasiliensis*** **2 F *Tadarida brasiliensis***
6/4/01	**Bee House-W**	**1 M *Monophyllus plethodon*** **1 F *Artibeus jamaicensis***

6/5/01	**Bee House-N**	**1 F *Sturnira lilium***
6/5/01	**Rodney's Rock**	**1 F *Artibeus jamaicensis*** **4 F *Tadarida brasiliensis*** **10 M *Tadarida brasiliensis*** **2 F *Molossus molossus*** **1 M *Molossus molossus***
6/6/01	**Guest House**	**1 F *Pteronotus davyi***
6/8/01	**Stinking Hole**	**1 F *Monophyllus plethodon*** **2 M *Natalus stramineus*** **2 M *Eptesicus fuscus*** **1 F *Eptesicus fuscus***

Table 2. Morphology Variables for *Molossus molossus*

Species	Sex	Forearm	Tail	Hind leg	Weight	Ref #
1	1	36	33	7	MD	7
1	1	35	36	6	MD	13
1	1	37.8	35.9	6.2	12	43
1	1	39.1	30.6	7.5	16	75
1	2	36	35	5	MD	1
1	2	38	32	6	MD	6
1	2	38	36	6	MD	8
1	2	38	29	6	MD	9
1	2	37	37	6	MD	10
1	2	36	35	6	MD	11
1	2	38	35	6	MD	12
1	2	36	38	7	MD	15
1	2	35	32	6	MD	16
1	2	34.8	32.7	6.1	MD	17
1	2	34.6	32	5.1	MD	19
1	2	31.9	30.6	4.1	MD	20
1	2	33.2	35.4	6	MD	21
1	2	33.7	35.7	6.3	MD	22
1	2	33.9	29.2	5	MD	23
1	2	32.9	28.9	6.1	MD	24
1	2	34.5	38.7	4.8	MD	25
1	2	36.9	28.1	6.5	12	41
1	2	39.2	32.3	6.4	15	42
1	2	36	27.1	6.1	MD	65
1	2	39.9	31.1	6.6	15	69

Table 3. Mean and Standard Deviation for Morphology Variables for *Molossus molossus*

DESCRIPTIVE STATISTICS FOR SEX = 1

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	4	36.975	1.8301	35.000	39.100
HINDFOOT	4	6.6750	0.6994	6.0000	7.5000
TAIL	4	33.875	2.5889	30.600	36.000
WEIGHT	2	14.000	2.8284	12.000	16.000

DESCRIPTIVE STATISTICS FOR SEX = 2

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	21	35.881	2.1630	31.900	39.900
HINDFOOT	21	5.8619	0.6837	4.1000	7.0000
TAIL	21	32.895	3.3640	27.100	38.700
WEIGHT	3	14.000	1.7321	12.000	15.000

Table 4. Principle components for *Molossus molossus*

EIGENVALUES / EIGENVECTORS BASED ON CORRELATION MATRIX

	EIGENVALUES	PERCENT OF VARIANCE	CUMULATIVE PERCENT OF VARIANCE
1	1.56077	52.0	52.0
2	0.99773	33.3	85.3
3	0.44149	14.7	100.0

	VECTORS		
FACTOR	1	2	3
FOREARM	-0.7054	0.0524	0.7068
HINDFOOT	-0.7059	0.0384	-0.7073
TAIL	0.0642	0.9979	-0.0099

Figure 1. Factor Scores of Bats by Sex on the First Two Principle Components of Morphological Variables for *Molossus molossus*

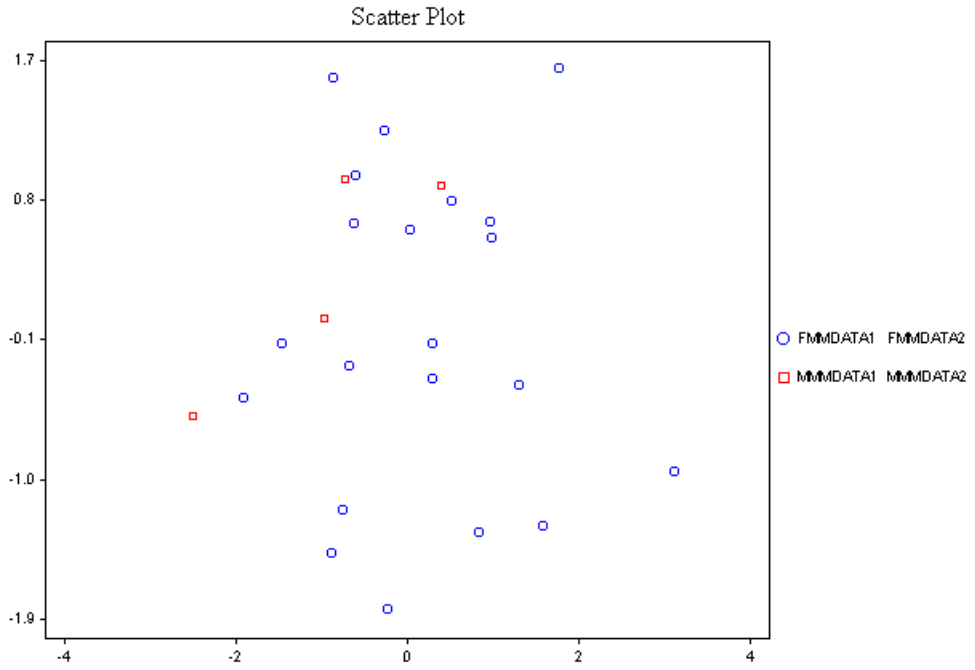

Table 5. Morphology Variables for *Tadarida brasiliensis*

Species	Sex	Forearm	Tail	Hind foot	Weight	Ref #
2	1	37	31.1	5.7	MD	27
2	1	36.5	26.6	5.3	9	29
2	1	36.9	26.7	5.4	9	30
2	1	38.6	25	6.7	11.5	36
2	1	36.2	27.6	5.8	8.5	39
2	1	36.4	25.4	5.1	8	40
2	1	37.3	28.4	6.5	9	45
2	1	36	25.2	5.6	9	46
2	1	36	29	6.2	9	48
2	1	36.3	29	6.5	9.5	49
2	1	37.1	28.9	5.6	14	50
2	1	37.7	28.7	5.4	9	51
2	1	36.0	30.5	6.5	10	52
2	1	36.3	29.8	6.4	10	53
2	1	37.8	29.6	6	11	55
2	1	36.7	30	6	13	56
2	1	37.9	29.7	6	10	57

Species	Sex	Forearm	Tail	Hind foot	Weight	Ref #
2	1	36.1	30.9	5.7	9	58
2	1	36.2	31.2	6	9	63
2	1	35.4	27.7	6.1	8	64
2	1	36.6	27.2	6.6	9	66
2	1	37.5	27	6.7	9	67
2	1	37.6	25.3	6.8	9	70
2	1	37.1	26.2	6.6	9	71
2	1	34.9	26.2	6.2	10	73
2	1	36.4	29.2	6.8	9	74
2	1	37	29.4	6.4	9	77
2	1	37.5	29.7	6.4	9	78
2	2	37.9	30	5.3	12	27
2	2	38.4	27.3	5	11	28
2	2	36.7	29.8	5.5	12	47
2	2	38.3	29.4	5.8	11	54
2	2	36.4	26.2	5.4	10	68
2	2	36.3	26.1	7	10	72
2	2	36.9	22.7	6.6	10	76

Table 6. Mean and Standard Deviation for Morphology Variables for *Tadarida brasiliensis*

DESCRIPTIVE STATISTICS FOR SEX = 1

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	28	36.750	0.8163	34.900	38.600
HINDFOOT	28	6.1071	0.4921	5.1000	6.8000
TAIL	28	28.257	1.9052	25.000	31.200
WEIGHT	27	9.5741	1.3707	8.0000	14.000

DESCRIPTIVE STATISTICS FOR SEX = 2

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	7	37.414	0.7967	36.400	38.400
HINDFOOT	7	5.8000	0.7326	5.0000	7.0000
TAIL	7	27.357	2.6375	22.700	30.000
WEIGHT	7	10.857	0.8997	10.000	12.000

Table 7. Principle Components for *Tadarida Brasiliensis*

EIGENVALUES / EIGENVECTORS BASED ON CORRELATION MATRIX

	EIGENVALUES	PERCENT OF VARIANCE	CUMULATIVE PERCENT OF VARIANCE
1	1.48706	37.2	37.2
2	1.07622	26.9	64.1
3	0.89319	22.3	86.4
4	0.54354	13.6	100.0

	VECTORS			
FACTOR	1	2	3	4
FOREARM	-0.5176	-0.6184	0.0110	0.5913
HINDFOOT	0.3559	-0.4862	-0.7770	-0.1825
TAIL	-0.3613	0.6084	-0.6240	0.3316
WEIGHT	-0.6892	-0.1056	-0.0823	-0.7121

Figure 2. Factor Scores of Bats by Sex on the First Two Principle Components of Morphological Variables for *Tadarida brasiliensis*

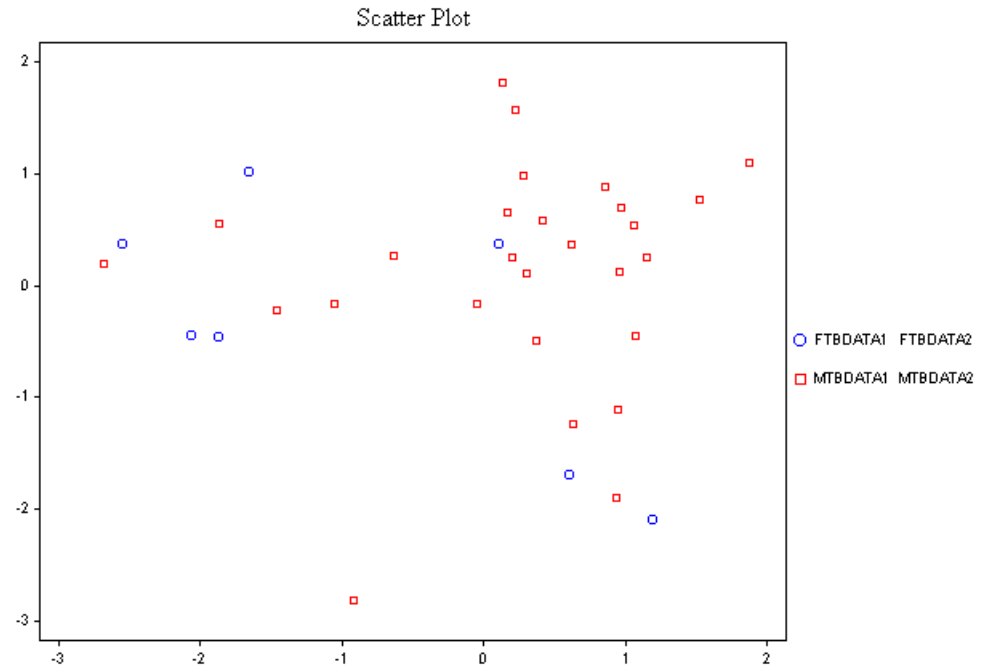

Table 8. Morphology Variables for *Artibeus jamaicensis*

Species	Sex	Forearm	Tail	Hind foot	Weight	Ref #
3	**1**	**61.1**	**No tail**	**11.7**	**42**	**35**
3	**1**	**58.9**	**No tail**	**11.2**	**51**	**44**
3	**2**	**63.2**	**No tail**	**11.2**	**MD**	**18**
3	**2**	**59.3**	**No tail**	**11**	**39**	**33**
3	**2**	**61.7**	**No tail**	**13.8**	**48**	**37**
3	**2**	**62.6**	**No tail**	**14.1**	**53.5**	**38**
3	**2**	**MD**	**No tail**	**MD**	**56**	**60**
3	**2**	**59.9**	**No tail**	**11.3**	**50**	**61**

Table 9. Mean and Standard Deviation of Morphology Variables for *Artibeus jamaicensis*

DESCRIPTIVE STATISTICS FOR SEX = 1

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	2	60.000	1.5556	58.900	61.100
HINDFOOT	2	11.450	0.3536	11.200	11.700
TAIL	0	MD	MD	MD	MD
WEIGHT	2	46.500	6.3640	42.000	51.000

DESCRIPTIVE STATISTICS FOR SEX = 2

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	5	61.340	1.6891	59.300	63.200
HINDFOOT	5	12.280	1.5320	11.000	14.100
TAIL	0	MD	MD	MD	MD
WEIGHT	5	49.300	6.5345	39.000	56.000

Table 10. Principal Components for *Artibeus jamaicensis*

EIGENVALUES / EIGENVECTORS BASED ON CORRELATION MATRIX

	EIGENVALUES	PERCENT OF VARIANCE	CUMULATIVE PERCENT OF VARIANCE
1	2.19505	73.2	73.2
2	0.73697	24.6	97.7
3	0.06797	2.3	100.0

	VECTORS		
FACTOR	1	2	3
FOREARM	0.6170	-0.4276	0.6607
HINDFOOT	0.6533	-0.1897	-0.7329
WEIGHT	0.4387	0.8839	0.1623

Figure 3. Factor Scores of Bats by Sex on the First Two Principle Components of Morphological Variables for *Artibeus jamaicensis*

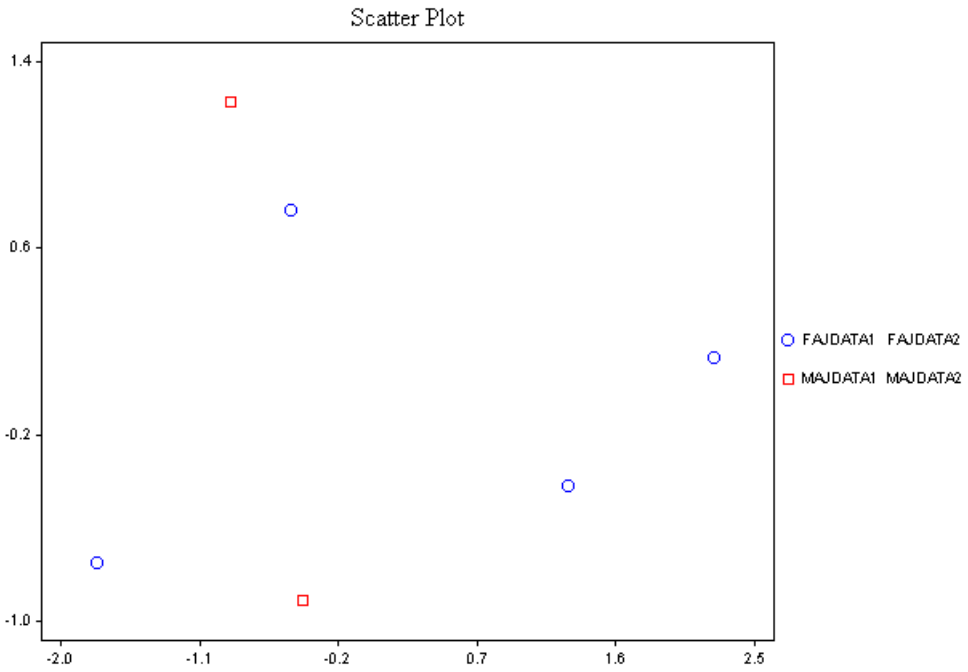

Table 11. Morphology Variables For Remaining Dominican Chiropterans

Species	Sex	Forearm	Tail	Hind foot	Weight	Ref #
Pteronotus davyi	**M**	**47.7**	**21.1**	**6.8**	**11.5**	**32**
Pteronotus davyi	**F**	**45.0**	**19.3**	**6.9**	**9**	**80**
Monophyllus plethodon	**M**	**40.7**	**12.1**	**9.7**	**16**	**59**
Monophyllus plethodon	**F**	**39.9**	**9.5**	**7.2**	**12**	**82**
Eptesicus fuscus	**M**	**45.8**	**45.3**	**9.6**	**12**	**81**
Eptesicus fuscus	**M**	**46.2**	**37**	**9.9**	**11**	**84**
Eptesicus fuscus	**F**	**48.7**	**42.5**	**8.0**	**13**	**83**
Natalus Stramineus	**M**	**34.8**	**26.6**	**4.5**	**4**	**31**
Natalus Stramineus	**M**	**32.4**	**28.1**	**7.0**	**5**	**85**
Natalus Stramineus	**M**	**33.5**	**27.3**	**6.6**	**4**	**86**

Table 12. Mean and Standard Deviation of Morphology Variables for *Eptesicus Fuscus*

DESCRIPTIVE STATISTICS FOR SEX = 1

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	2	46.000	0.2828	45.800	46.200
HINDFOOT	2	9.7500	0.2121	9.6000	9.9000
TAIL	2	41.150	5.8690	37.000	45.300
WEIGHT	2	11.500	0.7071	11.000	12.000

DESCRIPTIVE STATISTICS FOR SEX = 2

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	1	48.700	I D	48.700	48.700
HINDFOOT	1	8.0000	ID	8.0000	8.0000
TAIL	1	42.500	ID	42.500	42.500
WEIGHT	1	13.000	ID	13.000	13.000

Table 13. Mean and Standard Deviation of Morphology Variables for *Natalus stramineus*

DESCRIPTIVE STATISTICS FOR SEX=1

VARIABLE	N	MEAN	SD	MINIMUM	MAXIMUM
FOREARM	3	33.567	1.2014	32.400	34.800
HINDFOOT	3	6.0333	1.3429	4.5000	7.0000
TAIL	3	27.333	0.7506	26.600	28.100
WEIGHT	3	4.3333	0.5774	4.0000	5.0000

Discussion

No overall sexual dimorphism was detected in the bats sampled (Table 1). However, some variance in specific measurements was found.

The analysis of variance for *Molossus molossus* suggests that males have a larger hind foot than females (P=0.040). The sample size for weight measurements was too small to calculate. No weights were recorded on the first session (Table 2). Statistics for morphology variables of each sex are detailed in Table 3. Eigenvalues are the amount of variation explained by each principle variable. See Table 4 for principle components. The scatter plot (Figure 1) shows a slight separation of sexes.

The study found *Tadarida brasiliensis* to show dimorphism in two areas. According to the analysis of variance, females exhibited a marginally larger forearm (P=0.0617). The mean and standard deviation calculated from data in Table 5 showed a considerable difference in weight between males and males (Table 6). This may be artificially inflated because of the reproductive cycle. Females were observed to be gravid at this time of year. The eigenvalues based on correlation matrices are calculated in Table 7. The scatter plot in Figure 2 demonstrates some segregation by sex on the first two principle components.

Artibeus jamaicensis did not exhibit any sexual dimorphism. Four variables were computed (Table 8). Descriptive statistics are displayed in Table 9 and principle components are calculated in Table 10. The scatter plot (Figure 3) exhibits no trend. The sample size is too small to predict dimorphism with precision.

The netting efforts produced data on *P. davyi, M. plethodon, E. fuscus, and N. stramineus* (Table 11). The calculated mean and standard deviation for *Eptesicus fuscus* is displayed in Table 12. Table 13 shows the descriptive statistics for the male *N. stramineus* caught.

Conclusion

Sexual dimorphism was found in varying degrees among Dominican bats. No overall dimorphism was observed. However, there was a suggestion of sexual dimorphism among *M. molossus*. The hind feet of these Molossid males were larger than the females of the same species. *Tadarida* females showed marginally larger forearms than males. *Artibeus jamaicensis* showed no differences in morphology between the sexes. The data was insufficient for *E. fuscus, P. davyi, M. plethodon,* and *N. stramineus*. No conclusions can be made for these species. Type II errors may cloud the study.

It is my recommendation that further study be made of structure size and an effort made to compile data so that a precise conclusion can be made.

Acknowledgments

I am sincerely grateful to Dr. Thomas Lacher, Jr. and Dr. Bob Wharton for their daily guidance during this study. It would not have been possible without their efforts.

Also, I would like to thank Debbie Scott, Robin Reinhardt, and Alex Vilaythong for their assistance in data collection. They really made this project happen.