FEEDING AND HABITAT PREFERENCES OF THE RED-EARED SLIDER,

TRACHEMYS SCRIPTA ELEGANS WIED

A THESIS

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Associate Vice President for Research and
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I am submitting herewith a thesis written by Kimberly Jo Mauermann entitled "Feeding and Habitat Preferences of the Red-Eared Slider, *Trachemys scripta elegans* Wied." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science with a major in Biology.

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ABSTRACT

Mauermann, Kimberly J. Feeding and Habitat Preferences of the Red-Eared Slider, Trachemys scripta elegans Wied, (Unpublished) Thesis, Master of Science, Department of Biology, Texas Woman's University, December, 1995.

Feeding preferences of the red-eared slider among five common aquatic plant species were evaluated using paired comparison tests and a multiple comparison test. Statistical analysis of the paired comparison tests indicated the following preference order: Vallisneris americana = Hydrilla verticillata > Najas guadalupensis > Potamogeton nodosus = Myriophyllum spicatum. Statistical analysis of the multiple comparison test indicated the following preference order: V. americana > N. guadalupensis > H. verticillata > P. nodosus = M. spicatum. Although minor differences in the results of the two tests were observed, both confirmed that V. americana was highly preferred while P. nodosus and M. spicatum were least preferred.

To estimate the slider population, mark-recapture (Schnabel Method) was conducted for one year. The population was estimated at 705 (88 per hectare of surface water). Habitat preferences based solely on dominant plant species could not be demonstrated. However, sliders did appear to prefer ponds with well-established communities of both plants and animals.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Red-eared sliders (Trachemys scripta elegans Wied), increasingly rely on aquatic macrophytes for their primary source of nutrition as they mature into young adults, at about two years of age (Clark and Gibbons 1969). The literature suggests that sliders feed on a diversity of aquatic plants, submersed, floating and emergent. However, little research has been conducted to evaluate feeding preferences, or the impact of turtle herbivory on aquatic plant communities. Field observations indicate that turtle herbivory can impair efforts to establish certain species of aquatic plants, even in the presence of others (Carter and Rybicki 1985; Smart 1992).

If these herbivores exhibit feeding preferences, it is plausible that selective feeding will influence aquatic plant community species diversity and composition. It is also possible that sliders might utilize aquatic habitats, or areas within habitats, based upon presence of preferred plant species.

This study addresses 2 major objectives:

1. Investigate slider food preferences among five common aquatic plant species.

2. Estimate the population sizes of sliders in ponds at the Lewisville Aquatic Ecosystem Research Facility (LAERF), Lewisville, Texas, in order to examine possible relationships between population density and plant species present.

Hypotheses

1. When provided with a choice, turtles exhibit feeding preferences and selectively consume certain species of submersed aquatic plants.

2. Turtle population density is related to pond characteristics, principally influenced by the dominant aquatic plant species. Turtles will move out of less preferred habitats and into more preferred habitats, leading to higher population densities in the preferred habitats.

CHAPTER II

REVIEW OF LITERATURE

The red-eared sliders (Trachemys scripta elegans Wied) are placed in the family Emydidae with other pond, marsh and box turtles. They are a medium-sized (12.7-28.9 cm carapace length) turtle with rounded jaw and prominent red patches on the sides of the head. The carapace is olive to brown, weakly keeled and slightly serrated on the posterior margin. Yellow and green lines forming patterns on the scutes vary geographically. The hingeless plastron is usually pale yellow with varying dark spots. Old males usually exhibit melanism, having dark bodies and shells. Males also have foreleg claws about twice as long as those of females, thick tails with the anal opening posterior to the carapacial margin, and are slightly smaller than females (Ernst and Barbour 1972; Conant 1975; Garrett and Barker 1987; Behler and King 1989; Behler 1991; Conant and Collins 1991).

Sliders are usually found in lotic or lentic systems with dense vegetation and soft bottoms (Ernst 1971; Ernst and Barbour 1972; Conant 1975; Garrett and Barker 1987; Behler and King 1989; Behler 1991; Conant and Collins 1991). The geographic range of this species encompasses much of Texas, Oklahoma and the lower Mississippi River Valley.

Sliders are carnivorous at hatching, with a diet consisting primarily of small insects, invertebrates and vertebrates. Juveniles generally shift to a more omnivorous diet, consisting mostly of submersed aquatic plants, starting in their second year (Clark and Gibbons 1969). Clark and Gibbons (1969) suggested that juveniles require a carnivorous diet rich in calcium for proper growth and shell development. Parmenter and Avery (1990) showed that juveniles and adults require a diet with a crude protein concentration above 20% for proper growth. While a carnivorous diet may be more nutritionally advantageous for both adults and juveniles, this diet requires more energy to support the pursuit of mobile food items. Research by Parmenter (1980) and Bjorndal (1991) indicates adult turtles are opportunistic omnivores that prefer meat, when easily acquired and available, over other food items such as submersed aquatic plants. However, these authors suggested that as a turtle reaches a certain size it is no longer energetically able to satisfy its caloric requirements as a carnivore. A staple diet of submersed aquatic plants requires less energy for capture, and, if eaten in sufficient quantity, submersed aquatic plants provide a high percentage of the dietary and nutrient requirements, including calcium and protein (Clark and Gibbons 1969; Ernst 1971; Ernst and Barbour 1972; Hart 1983).

Maturity is achieved in 4 to 8 years, when a plastral length of 14.5 cm is attained. Growth rates vary depending upon food availability and water temperature (Ernst 1971; Parmenter 1980). Sliders are active at water temperatures above 10°C, with most growth occurring during spring and summer. The life span ranges from 20 to 40 years, depending on environmental conditions (Ernst 1971). Slider densities range from 20 to 1,025 per hectare in ponds and lakes (Ernst and Barbour 1972; Harless and Morlock 1979). A smaller range of 52 to 205 per hectare is commonly reported for suitable habitats (Harless and Morlock 1979; Gibbons 1990). Home ranges are 1 to 2 kilometers in streams and drainage ditches (Ernst and Barbour 1972).

While herbivory by grass carp (Young et al. 1983; Harberg and Modde 1985; Anderson and Pine 1991) and crayfish (Chambers et al. 1990) has been well documented, there is little published information on selective herbivory by turtles on aquatic plants. Tonapi and Varghese (1983) examined feeding preferences of the Indian freshwater turtle *Kachuga tectum tentoria* Gray. In a study using *Pistia stratiotes* Linn (waterlettuce), *Eichhornia crassipes* Solms (waterhyacinth), *Salvinia natans* Roxb (water fern), *Hydrilla verticillata* L. f. Royle, and *Lemna minor* Linn (duckweed), turtles consumed 125-250 g (fresh weight) of vegetation daily and preferred *E. crassipes*. Smart (1992) reported herbivory by freshwater turtles prevented establishment of vallisneria (Vallisneria americana) in a reservoir restoration project at Guntersville Reservoir in Alabama.

CHAPTER III

MATERIALS AND METHODS

This research was conducted at the LAERF in Lewisville, Texas. The LAERF is an experimental field station operated by the U.S. Army Corps of Engineers Waterways Experiment Station, and is located in Denton County, Texas, just south of the Lewisville Lake dam.

FOOD PREFERENCES. Turtles were collected in fall-in traps set in randomly selected ponds at the LAERF (Figure 1). Traps were constructed of 2.5 x 5 cm mesh caging, measured 76 cm x 60 cm x 55 cm, and included two 100 cm x 21 cm access ramps (Figure 2). The open top of the trap was lined with a 5 cm wide containment lip. Traps were kept afloat with four 3.6 kg plastic buoys (Figure 2). After deployment, traps were checked each morning over a 2-week period, and adult female turtles were removed and placed in outdoor 3.5 m diameter x 0.6 m high plastic pools. Basking sites were provided to allow the turtles to dry completely while they basked (Figure 3). Water flowed continuously, maintaining a depth of 30 cm. Water temperature ranged between 25 and 29°C prior to and

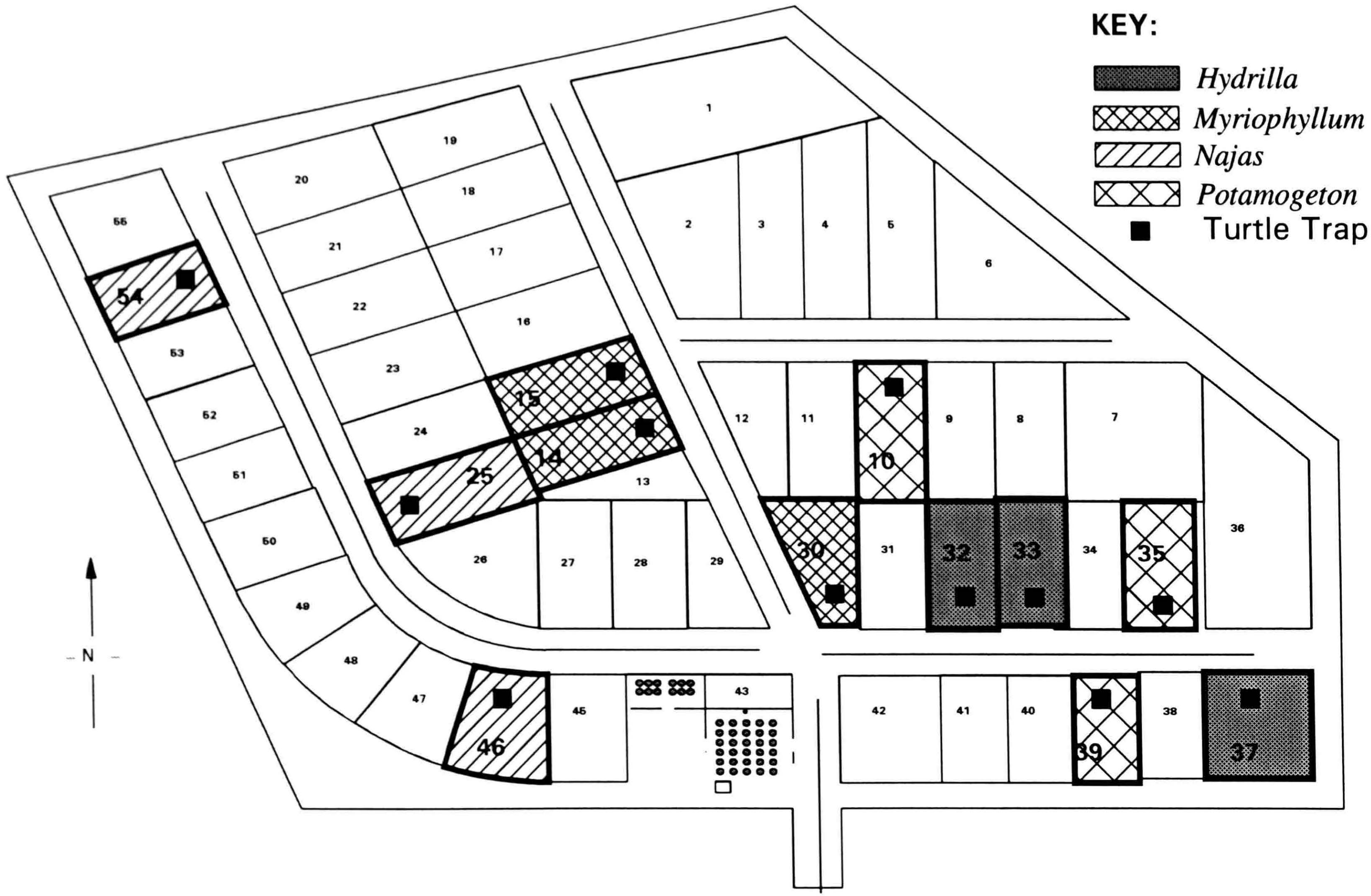

Figure 1. LAERF pond map showing the locations of turtle traps and the predomenant plant species found in the pond.

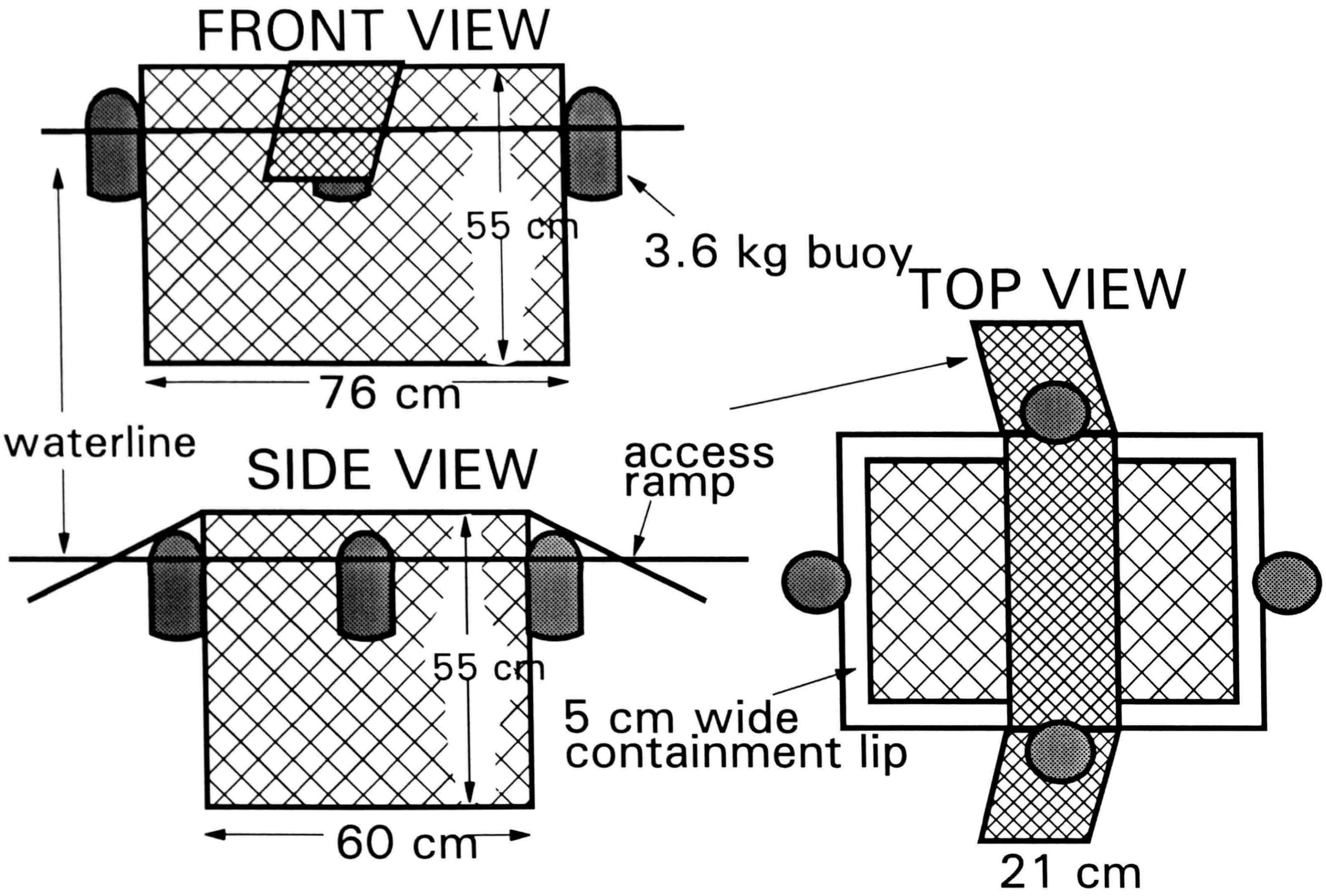

Figure 2. Fall-in turtle trap design. Waterline shown on side views.

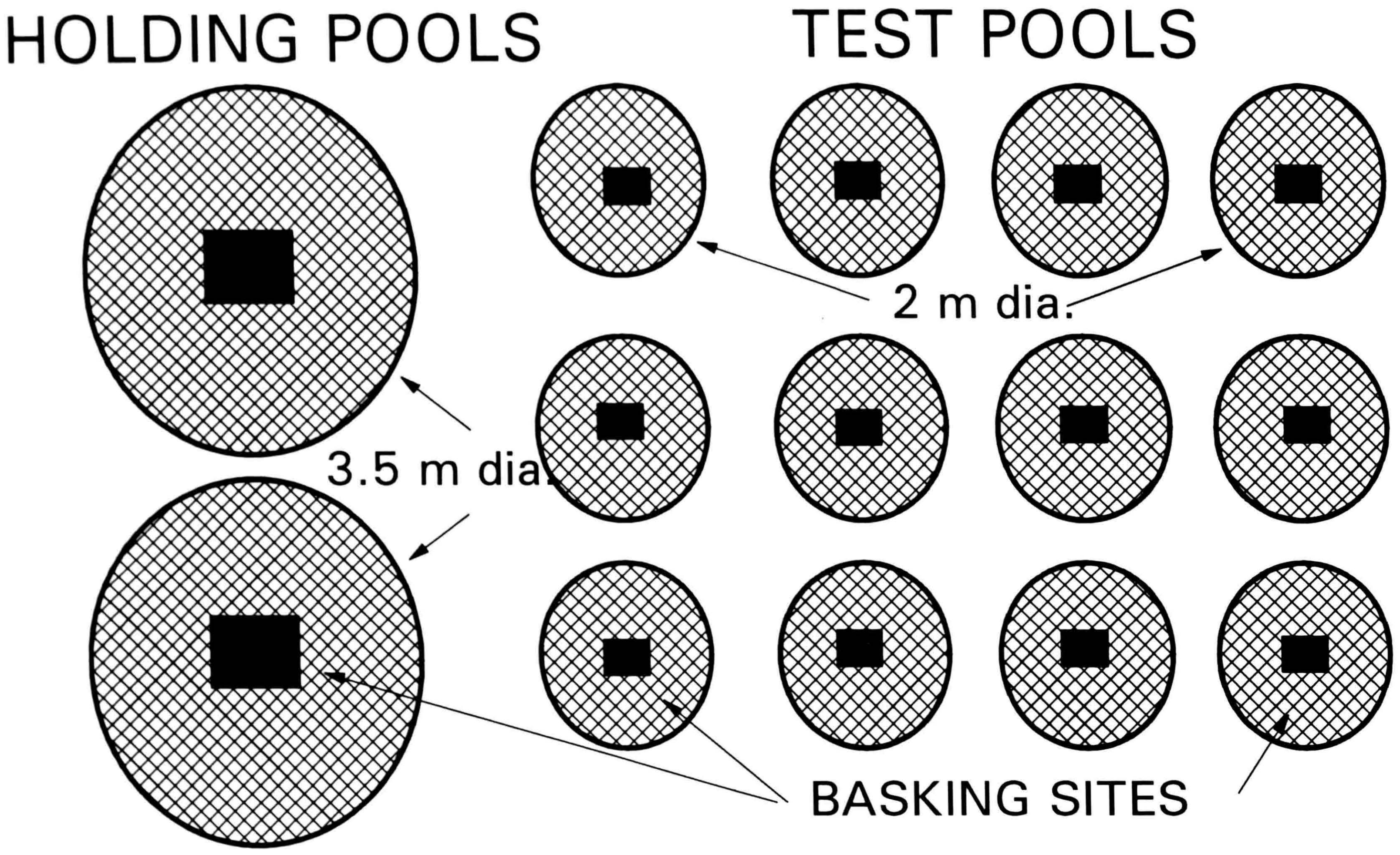

Figure 3. Experimental system design.

during the feeding preference tests. Turtles were fed ad libitum a variety of aquatic plants, including those species to be tested.

In order to reduce the variability among the test subjects, only mature female sliders of similar size were used in the food preference tests. Since mature females are approximately twice as large as mature males, and might require more energy to produce and lay eggs, it was concluded that the female sliders would provide more significant consumption that could be detected. Although males would probably have similar food preferences to females, there is no way to know for certain without testing and there is nothing in the literature at this time about food preference differences between the sexes. Tests were conducted under static conditions in twelve outdoor plastic pools measuring 2 m in diameter x 45 cm in height (Figure 3). Each pool was filled with Lewisville Lake water to a depth of 20 cm. This depth was maintained throughout testing by adding water when needed.

Plant species examined included hydrilla (Hydrilla verticillata L. f. Royle), Eurasian watermilfoil (Myriophyllum spicatum L.), southern naiad (Najas guadalupensis (Spreng.) Magnus.), American pondweed (Potamogeton nodosus Poir), and vallisneria (Vallisneria americana Michx). These species were chosen because they are common in many aquatic systems, and because they were readily available at the LAERF. Hydrilla and Eurasian watermilfoil are introduced weedy species that plague many reservoirs in North America (Dearden 1983; Gallagher and

Haller 1990). Vallisneria is a native submersed aquatic plant that provides excellent habitat for fish and other aquatic organisms, and is frequently used in lake revegetation and restoration projects (Smart 1992). Southern naiad and American pondweed are also common native species. Food preference tests included paired species and multiple species comparison tests. In the paired comparison test, plant species were offered in pairs. All possible paired combinations (10 total) were tested in a randomly selected order. In the multiple comparison test, all five plant species were offered simultaneously. The purpose of conducting both tests was to verify results of each test. After all testing was complete the sliders were released into Lewisville Lake at the emergency spillway.

Paired Comparison Feeding Tests

Sliders were chosen randomly from a pool of 24 individuals, excluding those tested on the previous day. One turtle was placed in each of the 12 test pools. Several kilograms of the plant species being tested were collected from cultures grown at the LAERF. Plants were spun by hand for 30 seconds in a wire basket to remove excess water, then bundles (200 g fresh weight) of each species were weighed out on an electronic top loading Mettler PM16 balance. Bundles were secured around the middle with a rubber band to hold the bundle together during testing. The plants bundles were then offered in pairs to each of 4 sliders held individually in test pools (Figure 3), with 3 species combinations tested each day. At the end of 24 h, plant bundles and fragments were collected and spun dry, and fresh weights obtained. Consumption was calculated by taking the final weight of a plant bundle plus the weight of same species fragments and subtracting that weight from initial weight of the bundle. Statistical analysis using a paired t-test was used to ascertain differences in total consumption (SAS 1994). Plant species consumed in significantly higher quantities were considered preferred.

Multiple Comparison Feeding Tests

Several kilograms of the five plant species were collected from cultures grown at the LAERF. Plants were spun by hand for 30 seconds in a wire basket to remove excess water, then processed to produce 12 bundles of each species, each 100 g fresh weight. One bundle of each species (five total) was offered concurrently to 12 turtles held in individual pools (Figure 3). Every 24 h, plant bundles and fragments were removed, spun dry, and weighed. After weighing, plant bundles were returned to the test pools. Plant fragments were not returned to test pools. This procedure was repeated every 24 h for 3 days. Consumption was calculated by taking the final weight of the plant bundle plus the weight of all same species fragments and subtracting that weight from initial weight of the bundle. Statistical analysis using Student-Newman-Keuls test was used to ascertain differences in consumption (SAS 1994). Plant species consumed at significantly higher rates were considered preferred.

Population Study

Slider populations were surveyed in 12 earthen ponds at the LAERF. These ponds ranged from 0.24 to 0.32 hectare in size with maximum depths of 2 m (Table 1). The ponds were supplied with water from Lewisville Lake. Following the assumption that habitat selection was based upon aquatic plant communities, ponds were chosen based upon the dominant ($\geq$ 50% area coverage) aquatic macrophyte species in each. Three ponds were dominated by hydrilla, three by Eurasian watermilfoil, three by American pondweed and three by southern naiad (Table 1). No vallisneria ponds were available. Floating fall-in traps were placed in the ponds for 1 year (Figure 2). Turtle traps were checked every 48 h at approximately 7:00 A.M. Turtles found in the traps were assumed to have been caught during the basking periods of the previous 48 h .

Trapped turtles were marked after their initial capture with a 1 g (3.2 cm x 1.2 cm) aluminum tag. Each tag was stamped with a unique number to allow identification of individual turtles. The tag was attached with a piece of plastic coated wire through a 0.31 cm diameter hole drilled through the posterior margin of

Table 1

Individual pond summaries of surface area in hectares and pond age.

Pond #	Species	Surface Area of Pond (ha.)	Percentage of surface area of each pond out of total surface area possible	Percentage of surface area of ponds grouped by species out of total surface area possible	Date pond established
32	hydrilla	0.26	8%	26%	1992
33		0.26	8%		1992
37		0.32	10%		1989
14	Eurasian watermilfoil	0.26	8%	26%	1992
15		0.30	9%		1992
30		0.26	8%		1989
25	Southern naiad	0.30	9%	24%	1992
46		0.24	8%		1989
54		0.24	8%		1992
10	American pondweed	0.26	8%	23%	1992
35		0.26	8%		1992
39		0.20	6%		1990
Grand Totals		3.20			
Means		0.26			

a carapace scute. Marked turtles were sexed, measured, and weighed, then released back into the pond from which they had been trapped (Appendix A).

Population estimates were made using the Schnabel Method, which involves marking and recapturing over time (Schnabel 1938). This method is frequently used when the animals being studied are difficult to capture and can be obtained only in small numbers (Cox 1985). The results provide a series of population estimates of increasing reliability.

A number of conditions must be met for Schnabel population estimates to be valid. First, no significant change may occur in the ratio of marked to total animals between release and recapture of the animals. Second, samples taken from the population must be random. Third, marked individuals must have the same random chance of being caught as unmarked individuals.

From the data obtained, population estimates were calculated for each recapture date using the following formula: $N_i = \Sigma M_i C_i / \Sigma R_i$, where N_i is the population estimate, C_i is a subsequent capture date after the first date, R_i is the number of marked recaptures and M_i is the total number of marked animals in the population, which will increase through time (Cox 1985).

CHAPTER IV

RESULTS AND DISCUSSION

Paired Comparison Feeding Tests

A summary of each feeding trial is given Table 2. When paired t-tests were used to determine the preference order, no differences were seen in consumption of vallisneria and hydrilla. Both of these species were consumed at greater rates than southern naiad. American pondweed and Eurasian watermilfoil were consumed at the lowest rate (Table 2).

Vallisneria was preferred over the alternate species in all of its trials except in the one with hydrilla. Here, in spite of a mean vallisneria consumption of 137 g compared to mean hydrilla consumption of 22 g, mean vallisneria consumption was not significantly different. The large standard error in this feeding trail probably obscured significant differences. The large standard error resulted from variability associated with individual turtle appetite in this particular feeding trial. Hydrilla was preferred over the alternate species in all of its trails except for the feeding trail with vallisneria were no significant difference was found.

Table 2

Individual t-tests in paired comparison results. The direction of the greater than sign indicates significant preference while the equals sign indicates no significant preference.

Species Tested	Mean Consumption	Prob > T $_{\alpha}$=0.05
vallisneria/hydrilla	137g = 22g	0.1599
vallisneria/Southern naiad	139g > 65g	0.0938
vallisneria/American pondweed	201g > 0.2g	0.0015
vallisneria/Eurasian watermilfoil	193g > 20g	0.0380
hydrilla/Southern naiad	160g > 92g	0.0195
hydrilla/American pondweed	114g > 38g	0.0799
hydrilla/Eurasian watermilfoil	111g > 74g	0.0681
Southern naiad/American pondweed	137g > 36g	0.0799
Southern naiad/Eurasian watermilfoil	105g > 27g	0.0290
American pondweed/Eurasian watermilfoil	0.4g = 47g	0.1632

Southern naiad was preferred over the American pondweed and Eurasian watermilfoil but not preferred over hydrilla and vallisneria. No significant difference was found between American pondweed and Eurasian watermilfoil even though mean consumption for American pondweed was 0.4 g and the mean consumption of Eurasian watermilfoil was 47 g. Here again, a large standard error arose from differences in individual turtle appetites in this particular feeding trial. Because of this high variability, no significant difference could be determined.

Assuming the preference order remained similar in the presence of additional species, the following overall preference order was indicated: vallisneria = hydrilla > southern naiad > American pondweed = Eurasian watermilfoil. However, when feeding trials were evaluated in order of total consumption, which were calculated by adding all the consumption for a plant species in all of the individual paired comparison feeding trials (Figure 4), differences between vallisneria and hydrilla were evident. Preferences between American pondweed and Eurasian watermilfoil remained unclear. Total consumption of all species by all turtles supports the observation that individual turtles, despite varying appetites, exhibit feeding preference between vallisneria and hydrilla. Interestingly, total consumption of southern naiad was also greater than total consumption of hydrilla (Figure 4).

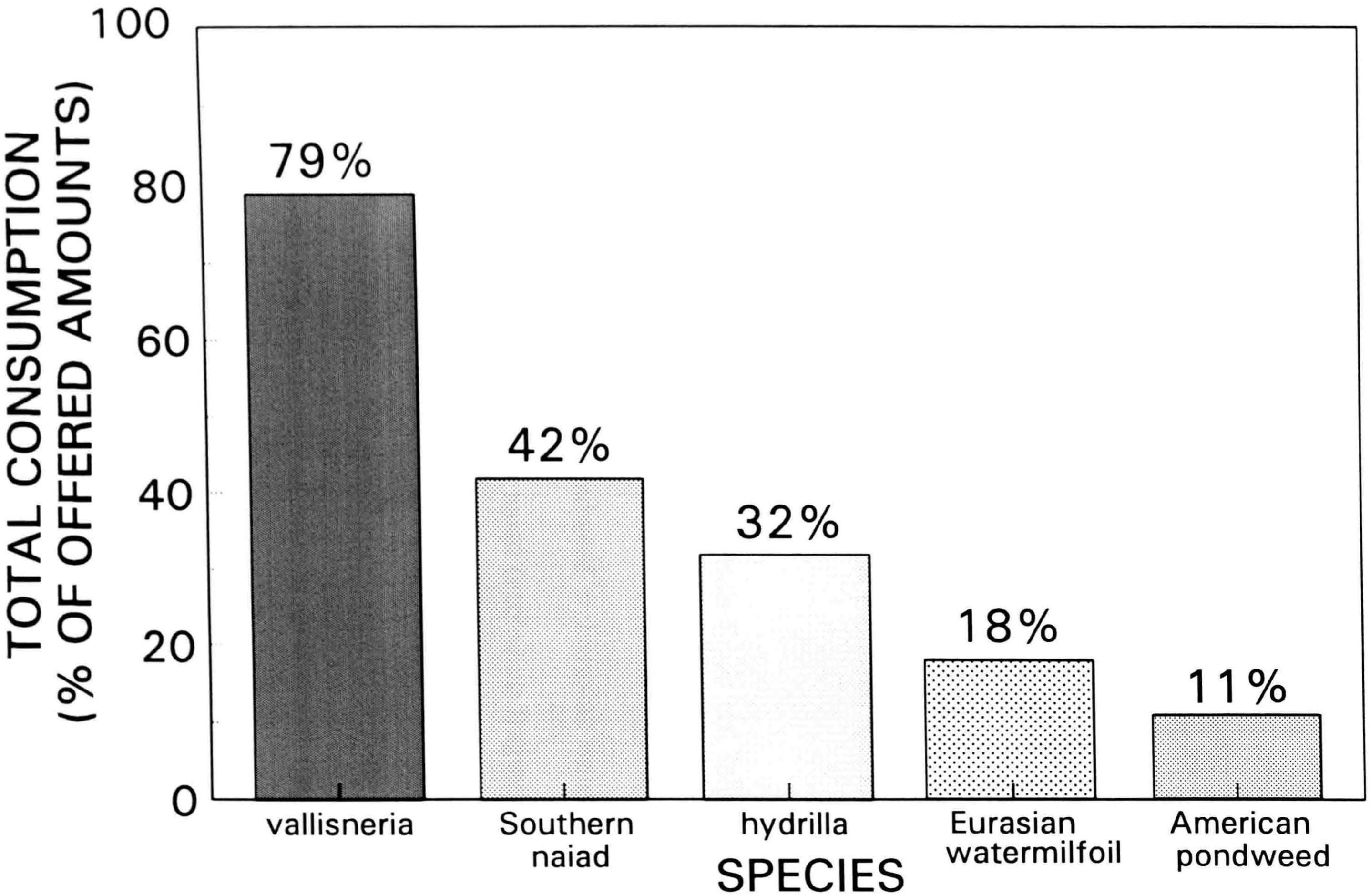

Figure 4. Overall consumption by species in paired comparison tests. Bars are percentage of total consumption.

Multiple Comparison Feeding Tests

Most consumption of plants occurred on day 1 (Figure 5). Sliders consumed an average of 166.0 g (range 80.5 to 271.9 g) out of 500.0 g on day 1 when all plant species were present. Mean consumption on the second day was 40.0 g (range 12.7 to 85.6 g). This lower consumption rate which occurred when only less preferred plants were present, implies that consumption of plants was reduced in the absence of preferred species. Consumption of less preferred species continued but at much lower rates.

Statistical analysis using the Student-Newman-Keuls test indicated the following preference order based upon consumption during day one: vallisneria > southern naiad > hydrilla = American pondweed = Eurasian watermilfoil (Figure 6). After 24 h all vallisneria and southern naiad (excluding fragments not returned) had been consumed by the turtles. The preference order for the remaining plants, based upon Student-Newman-Keuls for day 2 was hydrilla > American pondweed = Eurasian watermilfoil (Figure 7). No significant amounts of the remaining plants, mostly American pondweed and Eurasian watermilfoil, were consumed on day 3. From these data we can infer that the preference order was vallisneria > southern naiad > hydrilla > American pondweed = Eurasian watermilfoil. This preference order may indicate why there have been problems with turtle herbivory when trying to establish vallisneria in reservoir restoration projects (Smart 1992). If

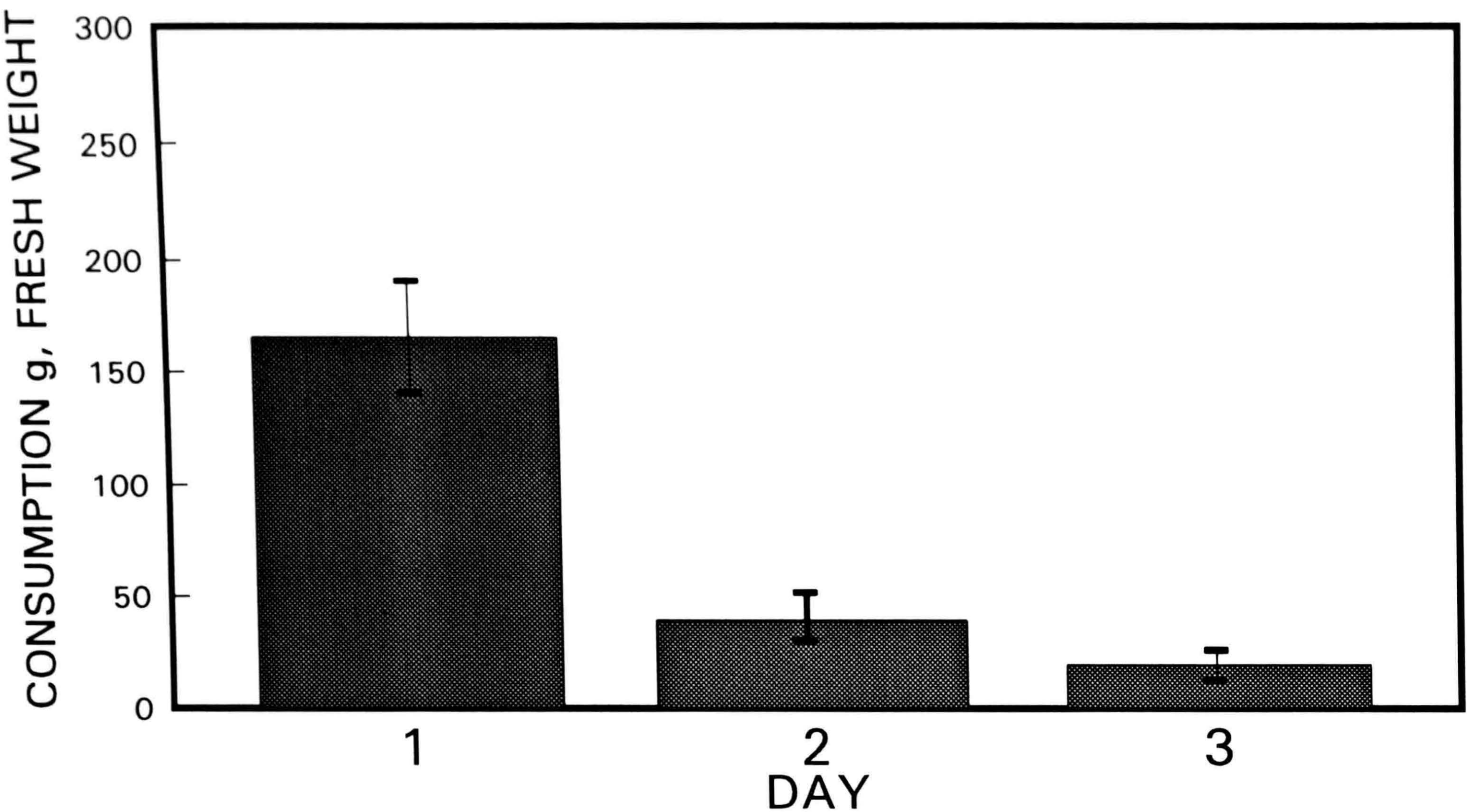

Figure 5. Total plant consumption by day in multiple comparison feeding test. Bars represent means of consumption (± standard errors).

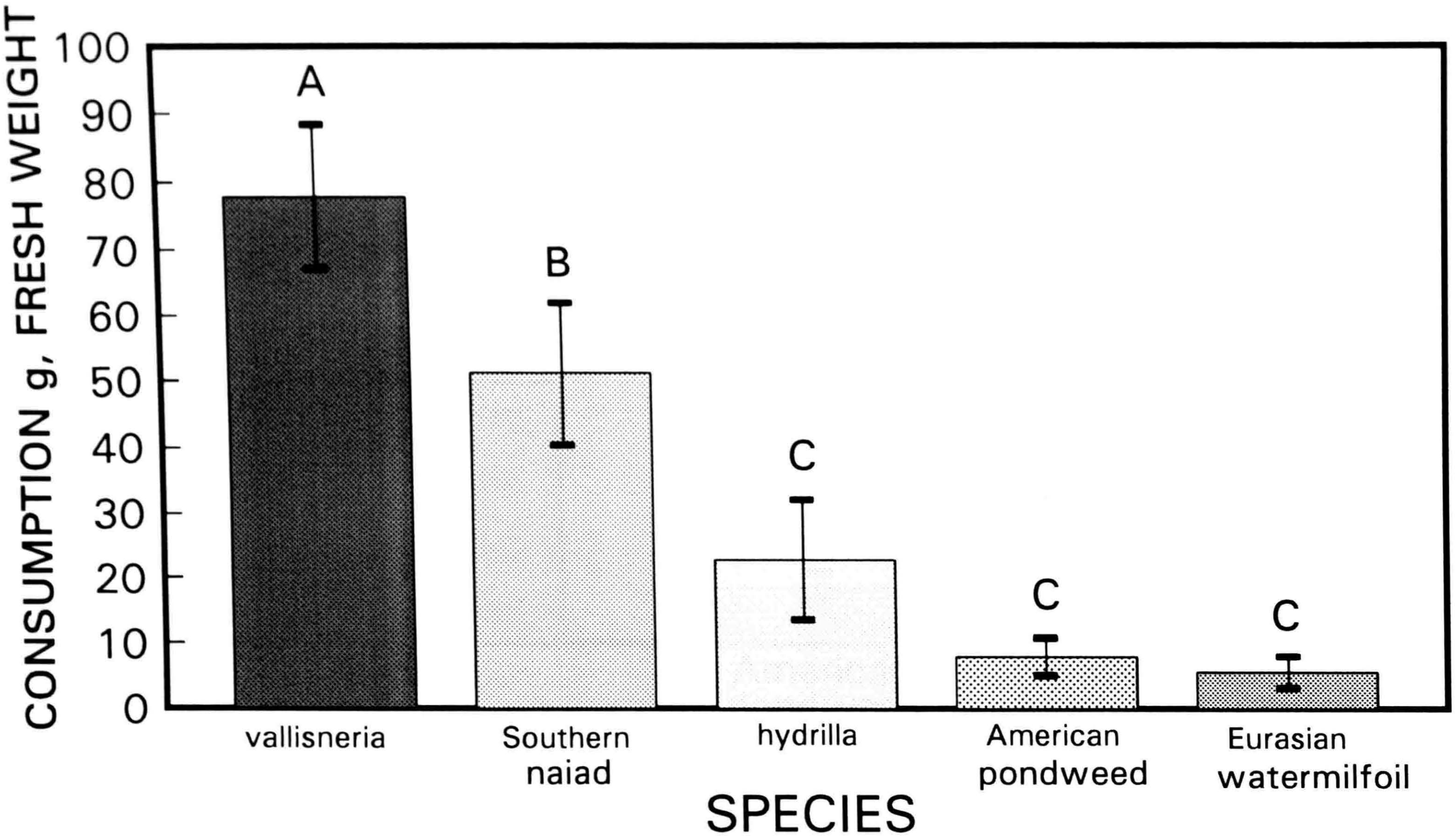

Figure 6. Consumption of plant species during day 1 in multiple comparison feeding test. Bars represent means of consumption (± standard errors). Different letters indicate significant difference at $\alpha = 0.05$.

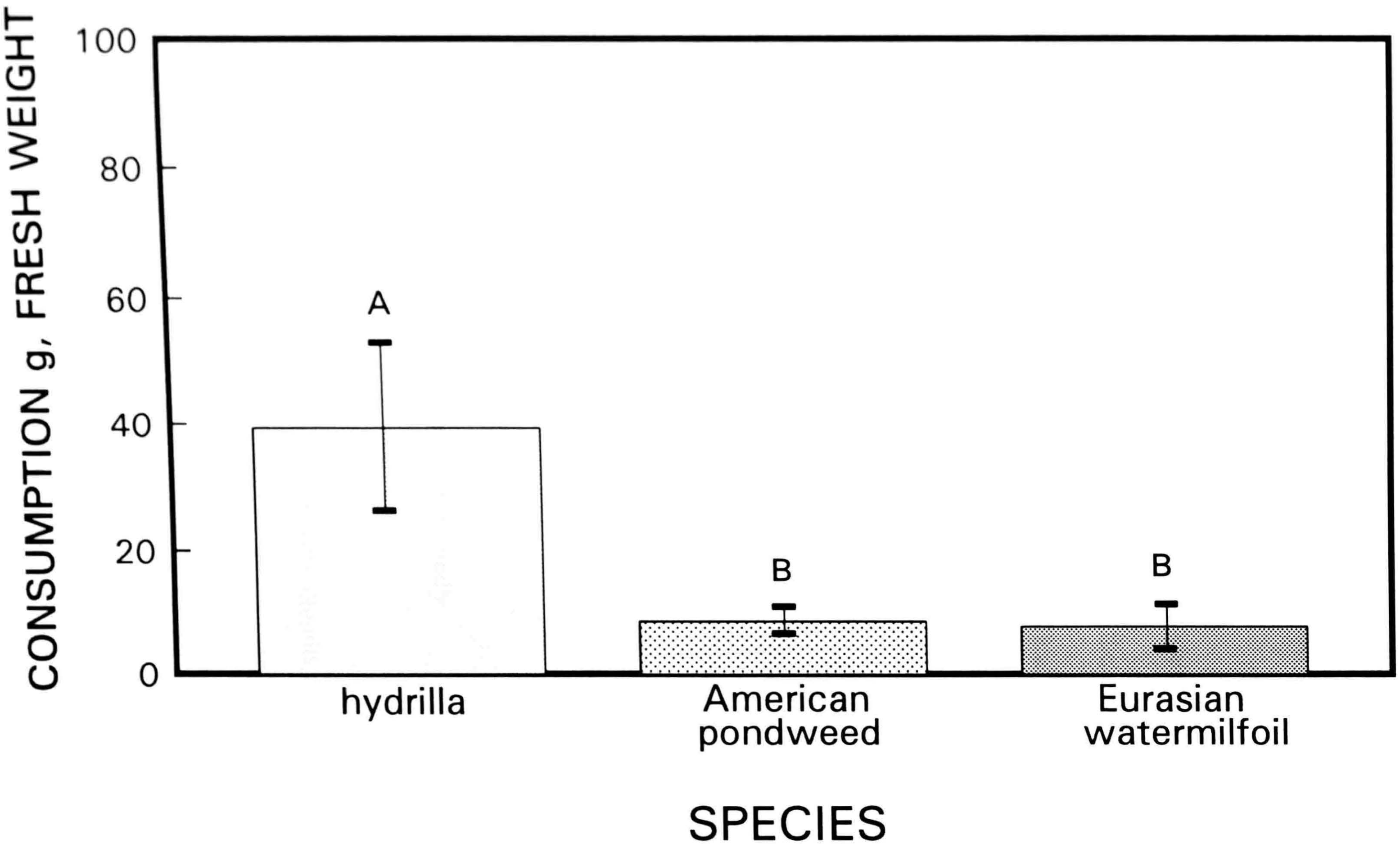

Figure 7. Consumption of less-favored plant species during days 1 and 2 in multiple comparison feeding test. Bars represent means of consumption ($\pm$ standard errors). Different letters indicate significant difference at $\alpha = 0.05$

the aquatic macrophyte that is being established is preferred over the other species present, the preferred plant may be selectively consumed by the local slider turtle population.

For the most part, the paired comparison and multiple comparison tests were in agreement. The multiple comparison test verified the observation that turtles preferred vallisneria over hydrilla, even though statistical analysis of paired test data had failed to detect this difference. The reversal in preference between hydrilla and southern naiad may have been in part an artifact of removal of fragments, which were highest in weight for southern naiad. Overall, it appears there were three groups of plants, based upon preference, of the five species tested. Vallisneria was clearly highly preferred. Southern naiad and hydrilla were readily consumed and therefore preferred. American pondweed and Eurasian watermilfoil were eaten only in the absence of others and therefore less preferred.

Population Study

During this investigation 213 sliders were caught and marked. Of these marked turtles, 180 were recaptured, for a total capture of 393 turtles. Individual pond summaries for total, marked and unmarked turtles trapped during the study are given in Tables 3 through 5. No significant differences were detected using a Kruskal-Wallis ANOVA ($\alpha=0.05$) between the numbers of total, marked and

Table 3

Individual pond summaries of total turtles trapped. (M-F-J) represents a breakdown of the number of turtles caught into male, female and juvenile numbers.

Pond #	Species	Total turtles trapped (M-F-J)	Percentage of total trapped	Total of turtles trapped for ponds	Avg. # of turtles trapped for ponds	Percentage of total trapped turtles for ponds
32 33 37	hydrilla	25 (15-6-4) 35 (23-10-2) 51 (32-7-12)	6% 9% 13%	111 (70-23-18)	37	28%
14 15 30	Eurasian watermilfoil	16 (15-1-0) 32 (18-11-3) 67 (42-14-11)	4% 8% 17%	115 (75-26-14)	38	29%
25 46 54	Southern naiad	34 (15-15-4) 21 (15-4-2) 6 (3-1-2)	8% 5% 2%	61 (33-20-8)	20	15%
10 35 39	American pondweed	21 (13-6-2) 36 (21-8-7) 49 (27-15-7)	5% 9% 12%	106 (61-29-16)	35	26%

Grand Totals	393
Means	33

Table 4

Individual pond summaries of recaptured turtles trapped. (M-F-J) represents a breakdown of the number of turtles caught into male, female and juvenile numbers.

Pond #	Species	Marked turtles trapped (M-F-J)	Percentage of marked trapped	Total of marked turtles trapped in ponds	Avg. # of turtles trapped for ponds	Percentage of total marked trapped turtles for ponds
32	hydrilla	16 (9-4-3)	9%	53 (29-13-11)	18	29%
33		17 (9-7-1)	9%			
37		20 (11-2-7)	11%			
14	Eurasian watermilfoil	7 (7-0-0)	4%	58 (38-10-10)	19	32%
15		14 (7-5-2)	8%			
30		37 (24-5-8)	21%			
25	Southern naiad	15 (5-10-0)	8%	22 (11-10-1)	7	12%
46		6 (6-0-0)	3%			
54		1 (0-0-1)	1%			
10	American pondweed	11 (7-3-1)	6%	47 (29-11-7)	16	26%
35		10 (6-2-2)	6%			
39		26 (16-6-4)	14%			
Grand Totals		180				
Means		15				

Table 5

Individual pond summaries of unmarked turtles trapped (during recapture effort) (M-F-J) represents a breakdown of the number of turtles caught into male, female, and juvenile numbers.

Pond #	Species	Total unmarked turtles trapped in pond (M-F-J)	Percentage of unmarked trapped in pond	Total unmarked turtles trapped in ponds	Avg. # of unmarked turtles trapped for ponds	Percentage of total unmarked trapped turtles for ponds
32 33 37	hydrilla	9 (5-2-2) 18 (13-4-1) 31 (21-5-5)	4% 8% 15%	58 (39-11-8)	19	27%
14 15 30	Eurasian watermilfoil	9 (8-1-0) 18 (11-5-2) 30 (18-9-3)	4% 8% 14%	57 (37-15-5)	19	27%
25 46 54	Southern naiad	19 (11-4-4) 15 (9-4-2) 5 (3-1-1)	9% 7% 2%	39 (23-9-7)	13	18%
10 35 39	American pondweed	10 (6-3-1) 26 (15-7-4) 23 (11-9-3)	5% 12% 11%	59 (32-19-8)	20	28%
Grand Totals		213				
Means		18				

unmarked turtles trapped in the various ponds based solely upon dominant plant species (Table 3, 4 and 5). However, in ponds with dense vegetation established for 3 or more years, (37 and 30) a significantly greater number of turtles were caught. Although numbers trapped from individual ponds do not necessarily represent populations in those ponds, the greater numbers trapped in long-term established ponds may have indicated that turtles have an affinity for more fully developed ecosystems. These ponds had not only had greater overall plant communities but established populations of invertebrates and vertebrates. Turtle occurrence (frequency of turtles present in different ponds) from pond to pond is given in Tables 6 and 7. These data indicate that recaptures were also higher in the older ponds (37 and 30). This further implies an affinity, or preference, for well-established communities.

Sliders at the LAERF were very mobile and moved from pond to pond freely. Because of this, and the low numbers of turtles trapped within individual ponds, individual population estimates for each pond were not possible. A population estimate was performed for the whole LAERF, including individuals collected from the twelve study ponds, four additional ponds and turtles caught by hand (Appendix A). The LAERF slider population was estimated at 705 (88 per hectare of surface water; Figure 8 and Appendix B). This population density is consistent with other populations studied by Ernst and Barbour (1972), who reported population densities of 72 to 153 per hectare in ponds and lakes. A smaller range of

Table 6

<u>Turtle occurrence summaries for ponds.</u>

Pond #	Species	The # of individual turtles that were captured in the pond	TOTAL	The # of individual turtles that were recaptured later in the same pond	TOTAL	The # of individual turtles that were recaptured later elsewhere	TOTAL	The # of individual turtles never recaptured again	TOTAL
32 33 37	hydrilla	25 35 51	111	4 4 11	19	7 13 13	33	14 18 27	59
14 15 30	Eurasian watermilfoil	16 32 67	115	1 3 19	23	4 9 9	22	11 20 39	70
25 46 54	Southern naiad	34 21 6	61	8 2 1	11	11 3 3	17	15 16 2	33
10 35 39	American pondweed	21 36 49	106	1 2 10	13	6 16 9	31	14 18 30	62

Table 7

Turtle occurrence summaries for ponds, with numbers broken down by sex.

Pond #	Species	The # of individual turtles that were captured in the pond M-F-J	TOTAL	The # of individual turtles that were recaptured later in the same pond M-F-J	TOTAL	The # of individual turtles that were recaptured later elsewhere M-F-J	TOTAL	The # of individual turtles never recaptured M-F-J	TOTAL
32	hydrilla	15-6-4	70-23-18	2-1-1	11-3-6	4-1-2	20-6-7	9-4-1	40-14-5
33		23-10-2		4-1-0		9-3-1		11-6-1	
37		32-7-12		5-1-5		7-2-4		20-4-3	
14	Eurasian watermilfoil	15-1-0	75-26-14	1-0-0	13-3-8	4-0-0	14-8-0	10-1-0	48-16-6
15		18-11-3		1-1-1		6-3-0		11-7-2	
30		42-14-11		10-2-7		4-5-0		27-8-4	
25	Southern naiad	15-15-4	33-20-8	1-7-0	3-7-1	6-3-2	10-4-3	8-5-2	20-9-4
46		15-4-2		2-0-0		2-0-1		11-4-1	
54		3-1-2		0-0-1		2-1-0		1-0-1	
10	American pondweed	13-6-2	61-29-16	1-0-0	8-3-2	4-1-1	18-8-5	8-5-1	34-19-9
35		21-8-7		1-0-1		11-3-2		8-6-4	
39		27-15-7		6-3-1		3-4-2		18-8-4	

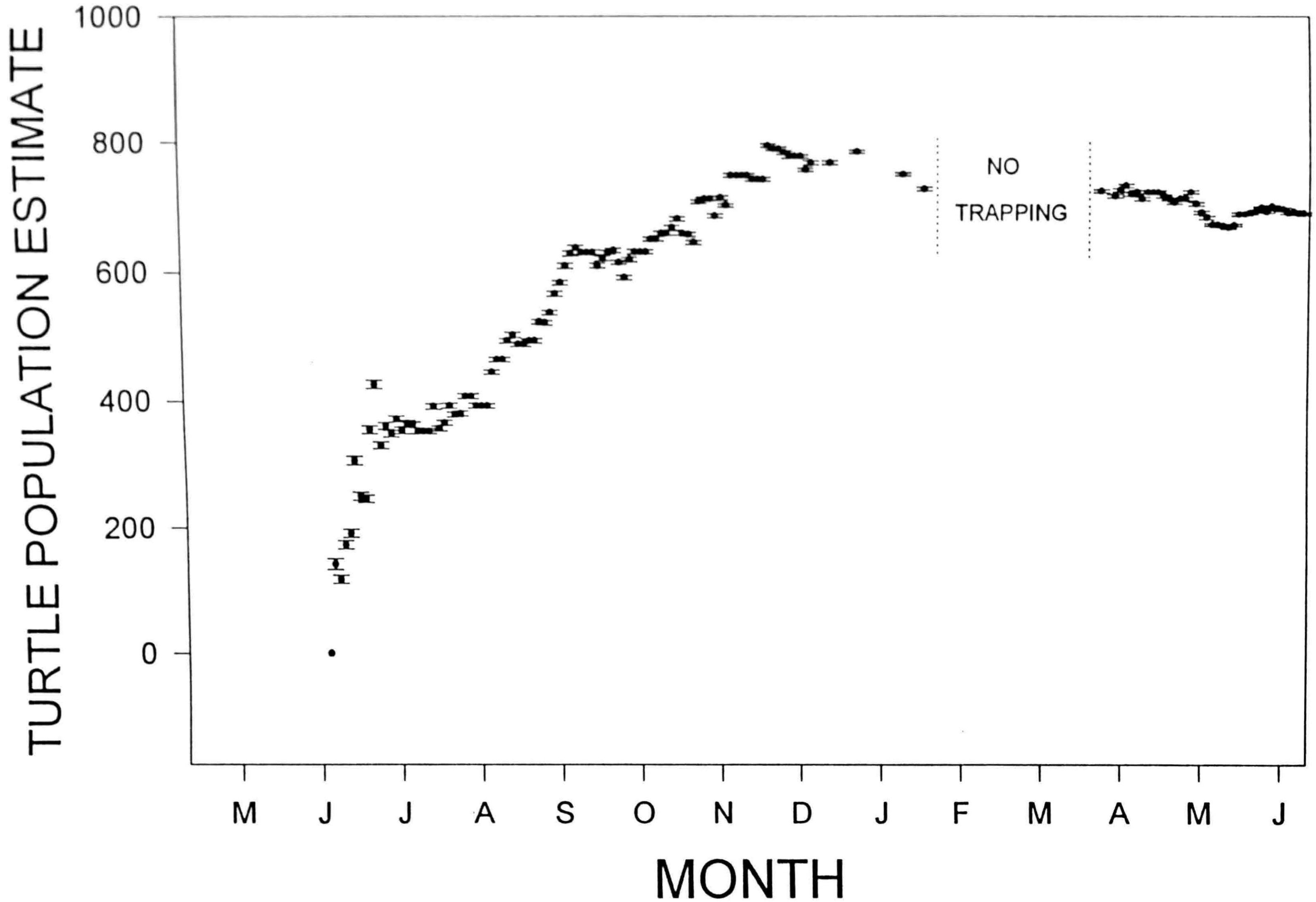

Figure 8. Turtle population estimates for 12 months (June 1992 thru June 1993) using the Schnabel method.
Dots indicate population estimates (± standard errors).

52 to 205 per hectare is commonly reported for suitable habitats (Harless and Morlock 1979; Gibbons 1990).

The sex ratio for all turtles trapped was 4:2:1 males, females, juveniles respectively. Reported sex ratios of other turtle populations examined elsewhere in the wild have been variable but generally approach 1:1 (Cagle 1950; Webb 1961). It is possible that the trap used selected for smaller turtles, and, since males are typically smaller than females this might account for the variation from the expected ratio. However, if this were true, juvenile captures would also be higher than those found elsewhere since juveniles are also smaller than females. Juvenile populations are generally reported as being less than 20% of the mature population (Ream and Ream 1966). Juveniles only make up 13% of the total turtles caught at the LAERF, well within the normal limit, so the trap used does not seem to be discriminating based on size and thus was not selecting out the males. The unusual sex ratio found during this study at the LAERF is interesting. However, since examination of sex ratios was not one of the objectives in this research no further investigation was done.

CHAPTER V

CONCLUSIONS

The objectives of the experiments in this thesis were to (1) investigate whether or not sliders exhibit feeding preferences and selectively consume certain species of submersed aquatic plants; and (2) estimate population sizes in order to determine whether or not turtle density is related to pond characteristics, particularly the aquatic plant community present.

The results described for food preference and for the population study are consistent with those predicted in the hypotheses. Sliders exhibited feeding preferences and selectively consumed certain species of submersed aquatic plants. Slider density may also be related to pond characteristics, although the dominant species of aquatic plants is less a factor than hypothesized.

It is evident from this research that sliders preferentially selected some aquatic macrophytes over others in both the paired and multiple comparison tests. These results suggest that sliders may function as selective herbivores, choosing one plant species over another for consumption. Theoretically, in a plant community comprised of the five species tested (American pondweed, Eurasian watermilfoil, hydrilla, Southern naiad and vallisneria), sliders would exert the greatest pressures on vallisneria, the most preferred species. Eventually, this herbivory might reduce vallisneria's presence in the community. While vallisneria becomes reduced, other plant species, especially those least preferred, would increase.

Population sizes were estimated from mark-recapture data. While this did not indicate a clear preference for habitat based upon the dominant plant species present, they did appear to prefer more mature ponds with well-established communities of both plants and animals. Sliders are not strict herbivores, and will exhibit carnivory when suitable prey is easily available. Observations in this study suggest that sliders do not choose habitats based solely upon the presence or absence of a particular plant species. However, if ponds with vallisneria had been available, a preference might have been detected since vallisneria is the most highly preferred plant species.

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APPENDICES

APPENDIX A

TAGGING INFORMATION

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
20 M	11	7/12/92	30	7/20/92																
34 M	35	6/30/92																		
35 M	11	7/12/92	30	7/20/92																
36 M	39	6/28/92																		
47 M	15	10/20/92																		
102 F	16(27)	3/26/93																		
109 M	39	6/6/92																		
110 M	30	6/2/92																		
111 M	37	6/2/92																		
112 M	37	6/2/92																		
113 M	37	6/2/92																		
114 M	37	6/2/92																		
115 M	37	6/2/92	37	6/4/92																
116 F	31(26)	6/4/92																		
117 F	10	6/4/92	35	4/11/93																
118 F	10	6/4/92																		
119 M	30	6/4/92	10	6/22/92																
120 F	37	6/4/92	36(38)	6/6/92																
121 M	37	6/4/92																		
122 M	54	6/4/92																		
123 M	25	6/4/92	14	8/5/92																
124 F	26	6/4/92	25	6/16/92	25	7/14/92														
125 F	1	6/6/92																		
126 M	40	6/6/92	36(38)	8/9/92																
127 F	17(38)	6/8/92	39	10/14/92	39	4/19/93	39	4/27/93	39	5/1/93										
128 F	12	6/8/92	33	10/20/92	41(38)	10/28/92														
129 F	53	6/8/92																		
131 M	30	6/10/92																		
132 M	30	6/12/92	30	6/14/92																
133 M	30	6/12/92																		
134 M	35	6/12/92	39	7/28/92																
135 M	35	6/12/92																		
136 M	37	6/12/92																		
137 M	30	6/14/92																		
138 M	35	6/14/92																		
139 F	54	6/14/92	25	6/24/92	25	1/20/92														
140 F	15	6/14/92	10	10/26/92																
141 F	15	6/14/92	25	6/24/92	25	6/30/92	25	7/6/92	25	7/12/92										
142 F	6	6/14/92																		
143 M	15	6/16/92																		
144 M	15	6/16/92	30	4/11/93																
145 F	41	6/16/92	37	6/14/92																
146 M	10	6/18/92	30	6/22/92																

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
147 M	10	6/18/92																		
148 F	39	6/18/92	47(38)	6/26/92	32	7/22/92														
149 M	46	6/18/92																		
150 M	13(26)	6/18/92	30	10/14/92																
151 M	15	6/18/92																		
152 F	22	6/18/92																		
153 M	30	6/20/92																		
154 M	42(38)	6/20/92																		
155 M	54	6/20/92																		
156 M	36(26)	6/20/92	35	6/26/92	40(38)	4/19/93	30	5/17/93												
157 F	PT	6/22/92																		
158 M	10	6/24/92																		
159 M	30	6/24/92																		
160 F	37	6/24/92																		
161 M	39(38)	6/24/92																		
162 M	25	6/24/92																		
163 M	13(26)	6/24/92																		
164 M	15	6/24/92	6(26)	5/19/93																
165 M	15	6/24/92																		
166 M	10	6/26/92																		
167 M	32	6/26/92	12(27)	7/492																
168 M	15	6/26/92																		
171 F	42	6/26/92																		
172 F	37	6/28/92	37	6/30/92																
173 M	37	6/30/92																		
174 M	46	6/30/92	46	7/14/92																
175 M	39	7/2/92	39	10/12/92	39(38)	10/20/92	32	1/4/93												
178 F	35	7/4/92																		
179 F	39	7/4/92																		
180 M	25	7/6/92	30	9/18/92																
183 M	35	7/12/92	40(38)	8/17/92																
184 M	37	7/12/92																		
185 M	46	7/12/92																		
186 M	15	7/12/92	30	6/9/93																
187 F	33	7/16/92																		
188 F	45	7/18/92																		
189 M	25	7/18/92																		
190 F	25	7/18/92																		
191 F	35	7/20/92																		
192 M	39	7/20/92	39	9/12/92	39	10/10/92	38	10/18/92	37	10/26/92	47(38)	1/4/93								
193 M	1(49)	7/22/92																		
194 M	1(49)	7/22/92	39	8/27/92																
195 F	37	7/24/92	FP(37)	9/12/92																

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
196 J	31(26)	7/24/92	13(26)	11/21/92																
197 M	31(26)	7/24/92	25	8/23/92																
198 M	32	8/3/92	32	8/17/92	32	10/22/92	30	10/28/92	30	10/30/92	30	11/1/92	30	11/3/92	30	3/28/93	9	5/25/93	32	6/9/93
199 M	33	8/3/92																		
200 F	6(26)	8/3/92	36(26)	5/13/93																
201 J	6(26)	8/3/92	33	9/20/92	39	4/19/93														
202 J	6(26)	8/3/92	26	11/1/92	10	11/13/92														
203 J	15	8/3/92	15	10/14/92																
204 M	33	8/5/92																		
205 F	25	8/5/92	29(26)	8/13/92	15	4/9/93														
206 F	25	8/5/92	25	8/21/92	35	10/16/92	33	6/9/93												
207 M	25	8/5/92	15	4/11/93																
208 F	10	8/9/92																		
209 F	30	8/9/92	10	8/23/92																
210 M	30	8/9/92																		
211 F	25	8/9/92	29(26)	8/13/92																
212 M	25	8/9/92																		
213 F	30	8/11/92																		
214 F	30	8/13/92	33	10/2/92	32	10/22/92	32	10/30/92												
215 M	29(26)	8/13/92	10	9/22/92																
216 M	32	8/17/92																		
217 M	33	8/17/92	33	9/14/92																
218 F	39	8/17/92	41(38)	9/20/92																
219 M	46	8/17/92																		
220 M	10	8/21/92	33	3/28/93	33	4/11/93	18(26)	4/27/93	33	6/9/93										
221 F	39	8/21/92																		
222 J	25	8/21/92																		
223 M	25	8/21/92	14	4/25/93																
224 M	14	8/21/92																		
225 J	30	8/23/92																		
226 M	33	8/23/92	10	3/26/93	30	3/30/93	30	4/19/93												
227 J	25	8/23/92																		
228 M	10	8/25/92	10	10/18/92																
229 J	35	8/25/92																		
230 J	30	8/27/92																		
231 J	54	8/27/92	54	9/6/92																
232 M	1(26)	8/27/92	17(26)	10/12/92	14	4/23/93														
233 M	1(26)	8/27/92																		
234 M	14	8/27/92	14	10/20/92																
236 J	ESCFP	?	40(38)	10/26/92	30	5/7/93														
237 M	13(49)	8/29/92	14	4/23/93	39	5/25/93														
238 M	13(49)	8/29/92																		
239 M	35	8/31/92																		

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
240 M	39(38)	8/31/92	33	1/12/93																
241 M	15	8/31/92																		
242 M	37	9/2/92	37	11/13/92																
243 M	25	9/2/92	25	10/10/92	25	10/18/92														
244 J	39	9/4/92	40(38)	9/24/92																
245 M	54	9/6/92	40(49)	10/6/92	14	3/30/93														
246 F	39	9/12/92																		
247 M	30	9/14/92																		
248 F	30	9/14/92																		
249 M	33	9/14/92	35	9/26/92	35	10/12/92	39	4/1/93	39	4/11/93	47(38)	5/11/93								
250 M	30	9/16/92	30	9/22/92																
251 F	30	9/18/92																		
252 M	30	9/18/92	32	10/26/92																
253 M	37(38)	9/20/92																		
254 M	40(38)	9/24/92																		
255 M	40(38)	9/24/92	37	4/21/93																
256 F	40(38)	9/24/92	39	4/27/93																
257 M	40(38)	9/24/92	39	5/15/93																
258 J	40(38)	9/24/92	39	10/26/92																
259 M	30	9/26/92	30	10/26/92	30	4/11/93														
260 M	35	9/26/92																		
261 M	35	9/26/92	32	10/22/92																
262 F	33	10/2/92																		
263 M	33	10/2/92	33	10/6/92	46	1/12/93														
264 M	35	10/2/92																		
265 M	39	10/2/92																		
266 J	10	10/6/92	32	10/22/92																
267 M	47(26)	10/6/92																		
268 M	47(26)	10/6/92	25	10/28/92																
269 M	47(26)	10/6/92	46	10/28/92																
270 M	37	10/10/92																		
271 M	39	10/10/92																		
272 J	25	10/10/92	17(26)	10/22/92	15	11/15/92														
273 M	14	10/10/92																		
274 M	30	10/12/92																		
275 F	17(26)	10/12/92																		
276 M	14	10/12/92																		
277 M	15	10/12/92	18(26)	4/27/93																
278 F	15	10/12/92																		
279 M	18	10/12/92	39	5/25/93																
280 F	39	10/14/92																		
281 F	35	10/16/92																		
282 M	33	10/18/92																		

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
283 M	39(38)	10/18/92	32	11/13/92	33	11/23/92														
284 F	32	10/20/92	15	4/23/93	10	6/2/93														
285 M	33	10/20/92	35	4/11/93																
286 M	33	10/20/92	10	10/26/92																
287 M	33	10/20/92	10	3/26/93	32	3/30/93														
288 J	37	10/20/92	37	10/22/92	37	10/26/92	41(38)	10/28/92												
289 J	37	10/20/92	37	10/26/92	37	10/28/92														
290 J	37	10/20/92	42(38)	4/21/93																
291 M	46	10/20/92	46	1/12/93																
292 M	46	10/20/92	25	11/29/92																
293 F	46	10/20/92																		
294 J	46	10/20/92																		
295 J	46	10/20/92	12	4/21/93																
296 F	35	10/22/92																		
297 J	35	10/22/92																		
298 F	35	10/22/92	33	3/28/93	33	3/30/93	30	4/13/93	30	5/7/93	30	6/2/93								
299 F	17(26)	10/22/92	15	5/17/93																
300 F	17(26)	10/22/92																		
301 M	17(26)	10/22/92	15	10/26/92	15	3/30/93														
302 M	17(26)	10/22/92																		
303 M	17(26)	10/22/92																		
304 J	30	10/26/92	30	11/13/92	30	4/11/93	30	4/13/93	30	4/19/93	30	4/21/93								
305 F	30	10/26/92	32	1/4/93																
306 M	37	10/26/92	30	5/17/93																
307 F	40(38)	10/26/92	42(38)	4/21/93	H/E(38)	5/1/93														
308 F	39	10/26/92																		
309 J	39	10/26/92																		
310 M	14	10/26/92																		
311 M	32	10/28/92																		
312 M	46	10/28/92																		
313 J	25	10/28/92	29(26)	3/19/93																
314 M	6	10/28/92																		
315 F	6	10/28/92	15	11/17/92																
316 M	6	10/28/92	35	3/28/93																
317 M	6	10/28/92																		
318 F	6	10/28/92																		
319 F	6	10/28/92	47(38)	5/11/93																
320 M	35	10/28/92	36(38)	11/29/92	47(38)	1/4/93														
321 J	35	10/28/92	35	3/28/93																
322 F	32	11/1/92																		
323 J	32	11/1/92	32	1/4/93	30	4/1/93	30	4/11/93												
324 J	37	11/1/92	47(38)	1/4/93																
325 M	39(38)	11/1/92																		

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
326 F	39(38)	11/1/92	30	4/13/93	39	5/29/93	30	6/2/93												
327 J	31(26)	11/1/92	47(38)	11/13/92																
328 M	31(26)	11/1/92	33	11/9/92	30	1/4/93	35	3/30/93	39	4/23/93	37	5/13/93	37	5/21/93						
329 M	31(26)	11/1/92																		
330 J	31(26)	11/1/92																		
331 J	31(26)	11/1/92																		
332 J	35	11/3/92																		
333 J	32	11/13/92	36(38)	11/29/92																
334 M	37	11/13/92	15	5/3/93	30	5/7/93	32	5/27/93												
335 J	47(38)	11/13/92																		
336 F	39	11/13/92																		
337 M	39	11/13/92	40(38)	4/19/93	39	4/23/93														
338 M	37	11/15/92	36(38)	11/29/92	42(38)	4/21/93	39	4/23/93												
339 J	37	11/15/92	35	1/12/93	37	5/11/93														
340 J	39	11/15/92	39	5/29/93																
341 J	39	11/15/92																		
342 M	25	11/15/92	29(26)	3/19/93																
343 M	14	11/15/92	15	4/9/93	14	4/25/93	19(26)	5/27/93												
344 J	16(26)	11/15/92																		
345 F	16(26)	11/15/92	25	1/4/93																
346 M	16(26)	11/15/92																		
347 F	16(26)	11/15/92	15	4/9/93	15	4/25/93														
348 J	33	12/1/92																		
349 M	14	12/1/92	15	5/7/93																
350 M	37	12/18/92																		
351 M	25	12/18/92	46	1/12/93																
352M	25	12/18/92																		
353 F	15	1/4/93																		
354 M	35	3/24/93	33	3/28/93	32	3/30/93														
355 F	30	3/24/93																		
356 F	30	3/26/93																		
357 F	39(38)	3/26/93																		
358 M	33	3/28/93																		
359 M	33	3/28/93																		
360 M	32	3/30/93	10	4/27/93																
361 M	33	3/30/93																		
362 M	35	3/30/93																		
363 F	35	3/30/93																		
364 F	35	3/30/93	33	4/11/93																
365 F	29(27)	3/30/93																		
366 M	35	4/3/93	39	5/7/93																
367 M	35	4/3/93	37	4/19/93	37	4/21/93	39	5/13/93	39	5/15/93	39	5/25/93								
368 M	35	4/9/93	37	4/19/93	37	5/5/93	37	5/13/93												

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP	DATE OF CAP	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
369 M	33	4/11/93																		
370 M	46	4/11/93																		
371 F	46	4/11/93																		
372 M	46	4/11/93	49	4/25/93																
373 F	46	4/11/93																		
374 F	14	4/11/93																		
375 M	14	4/13/93																		
376 M	30	4/19/93	30	5/1/93																
377 M	37	4/19/93	42(38)	4/21/93																
378 F	40(38)	4/19/93	33	4/23/93																
379 F	40(38)	4/19/93																		
380 M	40(38)	4/19/93	37	5/13/93																
381 F	29(27)	4/19/93																		
382 F	29(27)	4/19/93																		
383 M	42(38)	4/21/93	38	5/19/93																
384 F	15	4/23/93																		
385 M	37	4/25/93																		
386 M	1(38)	5/1/93																		
387 M	30	5/5/93	30	5/7/93																
388 M	37	5/5/93																		
389 F	10(9)	5/7/93																		
390 F	33	5/7/93																		
391 M	39	5/7/93																		
392 F	39	5/7/93	47(38)	5/27/93																
393 M	39	5/7/93																		
394 F	17(26)	5/7/93																		
395 M	47(38)	5/11/93	46	5/13/93																
396 F	47(38)	5/11/93																		
397 M	12	5/13/93																		
398 F	49	5/13/93																		
399 M	49	5/13/93																		
400 F	36(26)	5/13/93																		
401 M	37	5/15/93																		
403 F	R(15)	5/19/93	36(35)	5/25/93																
404 M	37	5/19/93	37	5/21/93																
405 M	37	5/19/93																		
406 M	39	5/25/93																		
407 F	9	5/27/93																		
408 F	37	5/27/93																		
409 F	19(26)	6/9/93																		
413 M	30	6/9/93																		
414 F	30	6/9/93																		
415 M	30	6/9/93																		

TAGGING INFORMATION*

TURTLE # AND SEX	POND # 1st CAP.	DATE OF CAP.	POND # 2nd CAP.	DATE OF CAP.	POND # 3rd CAP.	DATE OF CAP.	POND # 4th CAP.	DATE OF CAP.	POND # 5th CAP.	DATE OF CAP.	POND # 6th CAP.	DATE OF CAP.	POND # 7th CAP.	DATE OF CAP.	POND # 8th CAP.	DATE OF CAP.	POND # 9th CAP.	DATE OF CAP.	POND # 10th CAP.	DATE OF CAP.
416 F	46	6/9/93																		
417 M	15	6/9/93																		
418 M	15	6/9/93																		

* A pond number appearing in parentheses indicates the turtle was trapped or caught in a research pond from which it was removed. These individuals were released to the pond numbers outside of the parentheses. Letters outside the parentheses represent locations other than ponds where turtles were captured and/or released
(Key PT = Peach Tree, FP = Food Preference Area, ESCFP = Escaped Food Perference, HE = Header House, R = Upper Raceway)

APPENDIX B

POPULATION ESTIMATES BY THE SCHNABEL METHOD

POPULATION ESTIMATES BY THE SCHNABEL METHOD

DATE {i}	MARKED	SUM	CAPTURED {C_i}	SUM C	SUM {M_i*C_i}	RECAPTURES {R_i}	SUM R	NEW MARKS	DATE {i}	POPULATION ESTIMATE {N_i}	LOWER CL, 95%	UPPER CL, 95%	STD ERROR
02-Jun-92	6	0	6	6	0	0	0	6	06/02/92	0	0.0	0.0	0.0
04-Jun-92	9	9	10	16	144	1	1	9	06/04/92	144	127.6	160.4	8.3
06-Jun-92	3	12	4	20	240	1	2	3	06/06/92	120	107.7	132.3	6.3
08-Jun-92	3	15	3	23	345	0	2	3	06/08/92	173	159.7	185.3	6.6
10-Jun-92	1	16	1	24	384	0	2	1	06/10/92	192	179.9	204.1	6.2
12-Jun-92	5	21	5	29	609	0	2	5	06/12/92	305	290.6	318.4	7.1
14-Jun-92	6	27	8	37	999	2	4	6	06/14/92	250	238.1	261.4	6.0
16-Jun-92	3	30	4	41	1230	1	5	3	06/16/92	246	235.1	256.9	5.5
18-Jun-92	7	37	7	48	1776	0	5	7	06/18/92	355	342.9	367.5	6.3
20-Jun-92	4	41	4	52	2132	0	5	4	06/20/92	426	413.6	439.2	6.5
22-Jun-92	1	42	3	55	2310	2	7	1	06/22/92	330	319.3	340.7	5.5
24-Jun-92	8	50	10	65	3250	2	9	8	06/24/92	361	350.4	371.9	5.5
26-Jun-92	4	54	6	71	3834	2	11	4	06/26/92	349	338.4	358.7	5.2
28-Jun-92	2	56	2	73	4088	0	11	2	06/28/92	372	361.5	381.7	5.2
30-Jun-92	3	59	5	78	4602	2	13	3	06/30/92	354	344.5	363.5	4.9
02-Jul-92	1	60	1	79	4740	0	13	1	07/02/92	365	355.3	374.0	4.8
04-Jul-92	2	62	3	82	5084	1	14	2	07/04/92	363	354.1	372.2	4.6
06-Jul-92	1	63	2	84	5292	1	15	1	07/06/92	353	344.1	361.5	4.4
08-Jul-92	0	63	0	84	5292	0	15	0	07/08/92	353	344.4	361.2	4.3
10-Jul-92	0	63	0	84	5292	0	15	0	07/10/92	353	344.6	361.0	4.2
12-Jul-92	6	69	7	91	6279	1	16	6	07/12/92	392	384.0	400.9	4.3
14-Jul-92	0	69	2	93	6417	2	18	0	07/14/92	357	348.6	364.4	4.0
16-Jul-92	1	70	1	94	6580	0	18	1	07/16/92	366	357.7	373.4	4.0
18-Jul-92	3	73	3	97	7081	0	18	3	07/18/92	393	385.5	401.3	4.0
20-Jul-92	2	75	4	101	7575	2	20	2	07/20/92	379	371.1	386.4	3.9
22-Jul-92	2	77	3	104	8008	1	21	2	07/22/92	381	373.8	388.8	3.8
24-Jul-92	3	80	3	107	8560	0	21	3	07/24/92	408	400.0	415.2	3.9
26-Jul-92	0	80	0	107	8560	0	21	0	07/26/92	408	400.1	415.1	3.8
28-Jul-92	0	80	1	108	8640	1	22	0	07/28/92	393	385.5	399.9	3.7
30-Jul-92	0	80	0	108	8640	0	22	0	07/30/92	393	385.6	399.8	3.6
01-Aug-92	0	80	0	108	8640	0	22	0	08/01/92	393	385.8	399.7	3.6
03-Aug-92	6	86	6	114	9804	0	22	6	08/03/92	446	438.3	452.9	3.7
05-Aug-92	4	90	5	119	10710	1	23	4	08/05/92	466	458.3	473.0	3.8
07-Aug-92	0	90	0	119	10710	0	23	0	08/07/92	466	458.4	472.9	3.7

POPULATION ESTIMATES BY THE SCHNABEL METHOD

DATE {i}	MARKED	SUM	CAPTURED {C_i}	SUM C	SUM {M_i*C_i}	RECAPTURES {R_i}	SUM R	NEW MARKS	DATE {i}	POPULATION ESTIMATE {N_i}	LOWER CL, 95%	UPPER CL, 95%	STD ERROR
09-Aug-92	5	95	6	125	11875	1	24	5	08/09/92	495	487.4	502.2	3.8
11-Aug-92	1	96	1	126	12096	0	24	1	08/11/92	504	496.7	511.3	3.7
13-Aug-92	2	98	4	130	12740	2	26	2	08/13/92	490	482.9	497.1	3.6
15-Aug-92	0	98	0	130	12740	0	26	0	08/15/92	490	483.0	497.0	3.6
17-Aug-92	4	102	6	136	13872	2	28	4	08/17/92	495	488.4	502.4	3.6
19-Aug-92	0	102	0	136	13872	0	28	0	08/19/92	495	488.5	502.3	3.5
21-Aug-92	5	107	6	142	15194	1	29	5	08/21/92	524	516.9	530.9	3.6
23-Aug-92	3	110	5	147	16170	2	31	3	08/23/92	522	514.7	528.5	3.5
25-Aug-92	2	112	2	149	16688	0	31	2	08/25/92	538	531.4	545.3	3.5
27-Aug-92	5	117	6	155	18135	1	32	5	08/27/92	567	559.7	573.8	3.6
29-Aug-92	2	119	2	157	18683	0	32	2	08/29/92	584	576.8	590.9	3.6
31-Aug-92	3	122	3	160	19520	0	32	3	08/31/92	610	602.9	617.1	3.6
02-Sep-92	2	124	2	162	20088	0	32	2	09/02/92	628	620.6	634.9	3.7
04-Sep-92	1	125	1	163	20375	0	32	1	09/04/92	637	629.6	643.9	3.6
06-Sep-92	1	126	2	165	20790	1	33	1	09/06/92	630	623.0	637.0	3.6
08-Sep-92	0	126	0	165	20790	0	33	0	09/08/92	630	623.0	637.0	3.5
10-Sep-92	0	126	0	165	20790	0	33	0	09/10/92	630	623.1	636.9	3.5
12-Sep-92	1	127	3	168	21336	2	35	1	09/12/92	610	602.9	616.3	3.4
14-Sep-92	3	130	4	172	22360	1	36	3	09/14/92	621	614.4	627.8	3.4
16-Sep-92	1	131	1	173	22663	0	36	1	09/16/92	630	622.8	636.2	3.4
18-Sep-92	2	133	3	176	23408	1	37	2	09/18/92	633	626.0	639.3	3.4
20-Sep-92	1	134	3	179	23986	2	39	1	09/20/92	615	608.5	621.5	3.3
22-Sep-92	0	134	2	181	24254	2	41	0	09/22/92	592	585.2	597.9	3.2
24-Sep-92	5	139	6	187	25993	1	42	5	09/24/92	619	612.5	625.3	3.3
26-Sep-92	3	142	4	191	27122	1	43	3	09/26/92	631	624.3	637.2	3.3
28-Sep-92	0	142	0	191	27122	0	43	0	09/28/92	631	624.4	637.1	3.2
30-Sep-92	0	142	0	191	27122	0	43	0	09/30/92	631	624.4	637.0	3.2
02-Oct-92	4	146	5	196	28616	1	44	4	10/02/92	650	644.0	656.7	3.2
04-Oct-92	0	146	0	196	28616	0	44	0	10/04/92	650	644.1	656.7	3.2
06-Oct-92	4	150	6	202	30300	2	46	4	10/06/92	659	652.4	665.0	3.2
08-Oct-92	0	150	0	202	30300	0	46	0	10/08/92	659	652.5	664.9	3.2
10-Oct-92	4	154	6	208	32032	2	48	4	10/10/92	667	661.1	673.6	3.2
12-Oct-92	6	160	9	217	34720	3	51	6	10/12/92	681	674.5	687.0	3.2
14-Oct-92	1	161	4	221	35581	3	54	1	10/14/92	659	652.8	665.0	3.1

POPULATION ESTIMATES BY THE SCHNABEL METHOD

DATE ($_i$)	MARKED	SUM	CAPTURED (C_i)	SUM C	SUM (M_i*C_i)	RECAPTURES (R_i)	SUM R	NEW MARKS	DATE ($_i$)	POPULATION ESTIMATE (N_i)	LOWER CL, 95%	UPPER CL, 95%	STD ERROR
16-Oct-92	1	162	2	223	36126	1	55	1	10/16/92	657	650.8	662.9	3.1
18-Oct-92	2	164	5	228	37392	3	58	2	10/18/92	645	638.7	650.6	3.0
20-Oct-92	13	177	16	244	43188	3	61	13	10/20/92	708	701.8	714.2	3.2
22-Oct-92	8	185	14	258	47730	6	67	8	10/22/92	712	706.2	718.6	3.1
24-Oct-92	0	185	0	258	47730	0	67	0	10/24/92	712	706.3	718.5	3.1
26-Oct-92	7	192	17	275	52800	10	77	7	10/26/92	686	679.7	691.7	3.0
28-Oct-92	11	203	17	292	59276	6	83	11	10/28/92	714	708.1	720.2	3.1
30-Oct-92	0	203	2	294	59682	2	85	0	10/30/92	702	696.2	708.1	3.0
01-Nov-92	10	213	12	306	65178	2	87	10	11/01/92	749	743.1	755.3	3.1
03-Nov-92	1	214	2	308	65912	1	88	1	11/03/92	749	742.9	755.1	3.1
05-Nov-92	0	214	0	308	65912	0	88	0	11/05/92	749	743.0	755.0	3.1
07-Nov-92	0	214	0	308	65912	0	88	0	11/07/92	749	743.0	755.0	3.1
09-Nov-92	0	214	1	309	66126	1	89	0	11/09/92	743	737.1	748.9	3.0
11-Nov-92	0	214	0	309	66126	0	89	0	11/11/92	743	737.1	748.9	3.0
13-Nov-92	5	219	10	319	69861	5	94	5	11/13/92	743	737.3	749.1	3.0
15-Nov-92	10	229	11	330	75570	1	95	10	11/15/92	795	789.4	801.5	3.1
17-Nov-92	0	229	1	331	75799	1	96	0	11/17/92	790	783.6	795.5	3.0
19-Nov-92	0	229	0	331	75799	0	96	0	11/19/92	790	783.6	795.5	3.0
21-Nov-92	0	229	1	332	76028	1	97	0	11/21/92	784	777.9	789.7	3.0
23-Nov-92	0	229	1	333	76257	1	98	0	11/23/92	778	772.3	784.0	3.0
25-Nov-92	0	229	0	333	76257	0	98	0	11/25/92	778	772.3	783.9	3.0
27-Nov-92	0	229	0	333	76257	0	98	0	11/27/92	778	772.4	783.9	2.9
29-Nov-92	0	229	4	337	77173	4	102	0	11/29/92	757	750.9	762.2	2.9
01-Dec-92	2	231	2	339	78309	0	102	2	12/01/92	768	762.1	773.4	2.9
08-Dec-92	0	231	0	339	78309	0	102	0	12/08/92	768	762.1	773.4	2.9
18-Dec-92	3	234	3	342	80028	0	102	3	12/18/92	785	778.9	790.2	2.9
04-Jan-93	1	235	9	351	82485	8	110	1	01/04/93	750	744.4	755.4	2.8
12-Jan-93	0	235	5	356	83660	5	115	0	01/12/93	727	722.1	732.9	2.8
20-Jan-93	0	235	1	357	83895	1	116	0	01/20/93	723	717.9	728.6	2.7
19-Mar-93	0	235	2	359	84365	2	118	0	03/19/93	715	709.6	720.3	2.7
24-Mar-93	2	237	2	361	85557	0	118	2	03/24/93	725	719.7	730.4	2.7
26-Mar-93	3	240	5	366	87840	2	120	3	03/26/93	732	726.7	737.3	2.7
28-Mar-93	2	242	8	374	90508	6	126	2	03/28/93	718	713.1	723.6	2.7
30-Mar-93	6	248	13	387	95976	7	133	6	03/30/93	722	716.4	726.9	2.7

POPULATION ESTIMATES BY THE SCHNABEL METHOD

DATE {i}	MARKED	SUM	CAPTURED {C_i}	SUM C	SUM {M_i*C_i}	RECAPTURES {R_i}	SUM R	NEW MARKS	DATE {i}	POPULATION ESTIMATE {N_i}	LOWER CL, 95%	UPPER CL, 95%	STD ERROR
01-Apr-93	0	248	3	390	96720	3	136	0	04/01/93	711	706.0	716.4	2.6
03-Apr-93	2	250	2	392	98000	0	136	2	04/03/93	721	715.4	725.8	2.6
05-Apr-93	0	250	0	392	98000	0	136	0	04/05/93	721	715.4	725.7	2.6
07-Apr-93	0	250	0	392	98000	0	136	0	04/07/93	721	715.5	725.7	2.6
09-Apr-93	1	251	4	396	99396	3	139	1	04/09/93	715	710.0	720.2	2.6
11-Apr-93	6	257	16	412	105884	10	149	6	04/11/93	711	705.6	715.7	2.6
13-Apr-93	1	258	4	416	107328	3	152	1	04/13/93	706	701.1	711.1	2.6
15-Apr-93	1	259	1	417	108003	0	152	1	04/15/93	711	705.5	715.5	2.6
17-Apr-93	0	259	0	417	108003	0	152	0	04/17/93	711	705.6	715.5	2.5
19-Apr-93	7	266	14	431	114646	7	159	7	04/19/93	721	716.0	726.0	2.5
21-Apr-93	1	267	9	440	117480	8	167	1	04/21/93	703	698.6	708.4	2.5
23-Apr-93	1	268	8	448	120064	7	174	1	04/23/93	690	685.2	694.9	2.5
25-Apr-93	1	269	6	454	122126	5	179	1	04/25/93	682	677.5	687.1	2.4
27-Apr-93	0	269	5	459	123471	5	184	0	04/27/93	671	666.3	675.8	2.4
29-Apr-93	0	269	0	459	123471	0	184	0	04/29/93	671	666.3	675.8	2.4
01-May-93	1	270	4	463	125010	3	187	1	05/01/93	669	663.8	673.2	2.4
03-May-93	0	270	1	464	125280	1	188	0	05/03/93	666	661.7	671.0	2.4
05-May-93	1	271	1	465	126015	0	188	1	05/05/93	670	665.6	674.9	2.4
07-May-93	7	278	12	477	132606	5	193	7	05/07/93	687	682.4	691.8	2.4
09-May-93	0	278	0	477	132606	0	193	0	05/09/93	687	682.4	691.7	2.4
11-May-93	2	280	5	482	134960	3	196	2	05/11/93	689	683.9	693.2	2.4
13-May-93	4	284	10	492	139728	6	202	4	05/13/93	692	687.1	696.4	2.4
15-May-93	2	286	3	495	141570	1	203	2	05/15/93	697	692.7	702.0	2.4
17-May-93	0	286	3	498	142428	3	206	0	05/17/93	691	686.8	696.0	2.4
19-May-93	3	289	5	503	145367	2	208	3	05/19/93	699	694.3	703.5	2.4
21-May-93	0	289	2	505	145945	2	210	0	05/21/93	695	690.4	699.6	2.3
23-May-93	0	289	0	505	145945	0	210	0	05/23/93	695	690.4	699.5	2.3
25-May-93	1	290	6	511	148190	5	215	1	05/25/93	689	684.7	693.8	2.3
27-May-93	2	292	5	516	150672	3	218	2	05/27/93	691	686.7	695.7	2.3
29-May-93	0	292	2	518	151256	2	220	0	05/29/93	688	683.1	692.0	2.3
31-May-93	0	292	0	518	151256	0	220	0	05/31/93	688	683.1	692.0	2.3
02-Jun-93	0	292	3	521	152132	3	223	0	06/02/93	682	677.8	686.6	2.3
09-Jun-93	7	299	11	532	159068	4	227	7	06/09/93	701	696.3	705.2	2.3