

Home range and habitat preferences of Eastern Box Turtles (*Terrapene carolina carolina*) at Jug Bay Wetlands Sanctuary, Maryland

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ABSTRACT

We examined the home range characteristics of Eastern Box Turtles using three analytical methods: minimum convex polygon, bivariate normal, and 90% kernel. Only turtles with five or more sightings were used for this analysis, with a mean of 26 sightings for females (n = 49), 15 for males (n = 47), and 22 for juveniles (n = 4). Home range sizes were affected weakly if at all by the number of sightings. All calculation methods yielded significantly larger mean home ranges for females (12.9 ha) than for males (5.3 ha). Differences between male and female home ranges were greater for the sample of turtles tracked with radio telemetry than for those calculated from random encounters of marked turtles. Overall, females also used more of the available habitats than males. Excluding tidal wetland, both males and females were found at higher frequencies in each of the habitats, than expebason habitat availability. Females used forests, meadows, Phragmites marsh, and scrub-shrub wetland; males used mostly open and dense forests, stream flood plains and meadows; and juveniles used meadow and tidal wetland habitats more than did adults. The size and diversity of female home ranges has important conservation implications because, without recognition of these features, critical nesting and foraging habitats may be overlooked.

INTRODUCTION

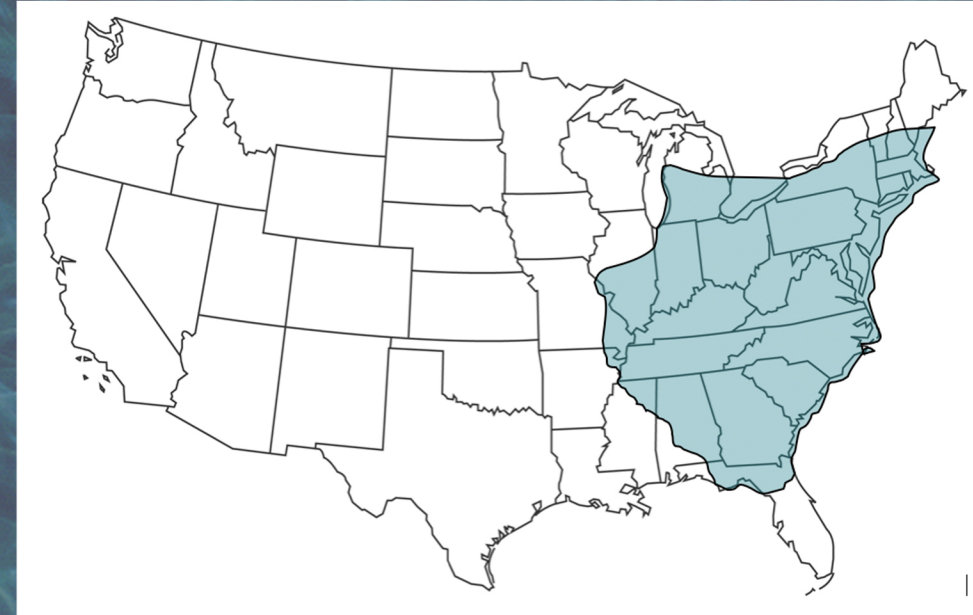


Fig. 1. Distribution of Eastern Box Turtles (*Terrapene carolina carolina*). Adapted from Dodd, 2001; Ernst *et al.* 1994.

The primary cause of population decline of turtles is the ever increasing rate of habitat loss (Mitchell and Klemens, 2000); thus, understanding the home range and habitat preferences of Eastern Box Turtle (*Terrapene carolina carolina*) is crucial for its conservation. Currently, box turtles are viewed as predominantly terrestrial; however, at the Jug Bay Wetlands Sanctuary in Eastern Maryland female (and more rarely male) Eastern Box Turtles include the tidal wetlands in their home ranges (Swarth, unpublished data). Since this result appears to be the only reported case of Eastern Box Turtles using a tidal environment, it is important to determine the significance tidal wetlands to box turtles.

In a recent study of Spotted Turtles, Milam and Melvin (2001) defined home range as “the area occupied by an animal for feeding, reproduction, and other activities essential to its survival, including sallies and extended trips outside core habitat-use areas.” Many researchers have not included movements to nesting habitats when calculating home ranges for female box turtles, explaining that these movements are “outside” of the home range (Stickel, 1950; Madden, 1975; Stickel, 1989; Dodd, 2001). Ranges calculated in this way have been described as the “utilized home range.” However, by omitting from home range calculations the movements or sallies to nesting areas, researchers are excluding the single most important activity of a female in the active season. We have adopted Milam and Melvin’s definition because sallies by turtles to nesting areas, as well as to overwintering sites in the fall, require turtles to travel through important and sometimes extensive areas of suitable habitat. An accurate and complete description of home range therefore should encompass all areas and habitats used by a turtle during the active period.

Study Objectives

The purpose of our analysis was to calculate and characterize box turtle home range and habitat preferences, expanding on an initial study by Marchand *et al.* (2004). We have attempted to answer the following questions:

- How large are the home ranges of Eastern Box Turtles, and do those of males differ from those of females?
- Does one home range measuring technique appear to be more accurate than another?
- What habitats do their home ranges include?
- What percentage of each habitat do the turtles use?
- Are some habitats preferred overall?

Study Area

The 55 Ha study area is in the Jug Bay Wetlands Sanctuary in central Maryland. The Sanctuary is operated by the Anne Arundel County Department of Recreation and Parks and is a member of the Chesapeake Bay National Estuarine Research Reserve, Maryland. The Sanctuary includes 1,400 acres of freshwater tidal wetlands, non-tidal aquatic habitats and dry upland habitats. The tidal wetlands fringe the Patuxent River (a Chesapeake Bay tributary), range in salinity from 0 to 2.0 ppt and have a semi-diurnal tide pattern with about 0.6m tidal amplitude. Tidal habitats are differentiated by the dominant vegetation: Scrub-Shrub (SS), *Phragmites* (PH), and Tidal marsh (TW). Upland habitats consist of meadows (M) and open and dense forests (OF and DF respectively). Non-tidal aquatic habitats include two year-round streams and seasonal vernal pools. These areas are referred to as floodplain (FP) habitats. The entire study area is marked with a grid of poles placed every 100 meters.

MATERIALS and METHODS

We examined ten years of location data (1995 – 2004) from 100 marked turtles (49 females, 47 males, and 4 juveniles), for a total of 2,060 sightings. Location data were derived from random encounters and by radio telemetry. ArcView Home Range Extension (HRE) and Animal Movement Extension were used to calculate the home range sizes. For comparative purposes and for increased accuracy, home ranges were also estimated by the Minimum Convex Polygon, Bivariate Normal (at 95% confidence), and Kernel (at 90% confidence) methods.

RESULTS

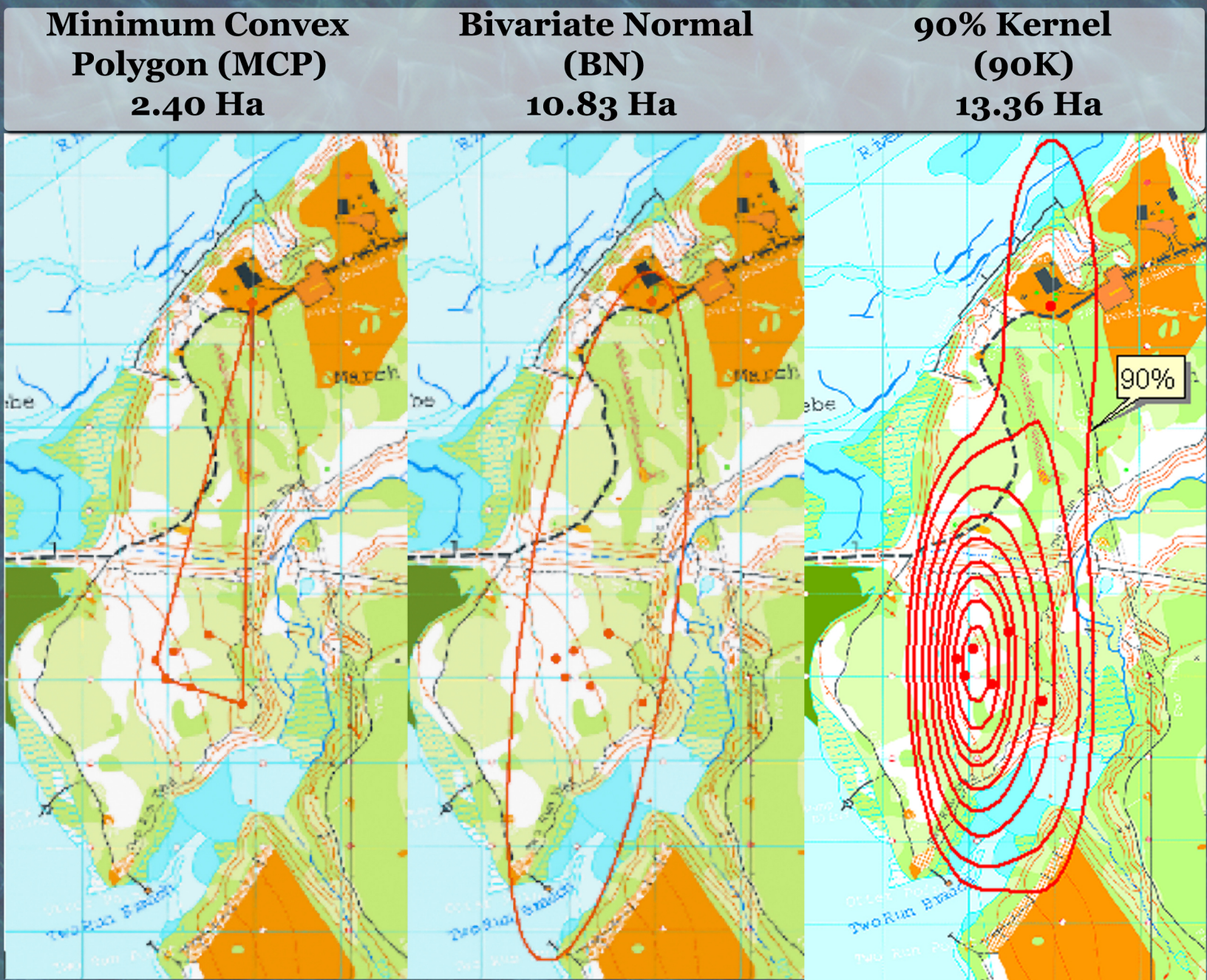


Fig. 2. Home range estimation methods can vary considerably to the same set of sightings. This represents the home range of Female #315.

Table 2. Significant differences between male and female home range sizes for each of the estimation methods for combined and telemetry sightings.

Home Range Method	Sightings Type	ANOVA P-Value	Fisher's PLSD P-Value
MCP	Combined	0.0392	0.0125
	Telemetry	0.0759	0.0294
BN	Combined	0.0288	0.0269
	Telemetry	0.0383	0.0365
90% Kernel	Combined	0.0430	0.0131
	Telemetry	0.0417	0.0138

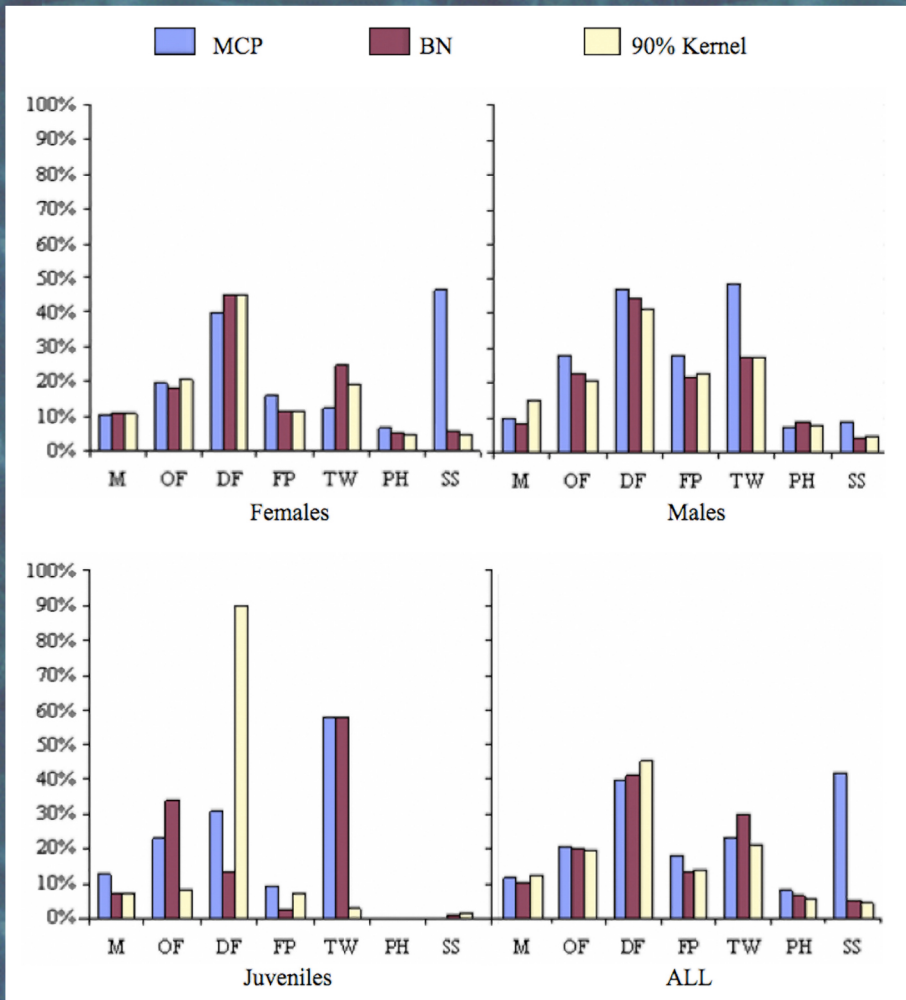


Fig. 4. Comparative habitat preferences among the three home range estimation methods. Percent habitat use is based on mean habitat use divided by mean home range area.

Table 3. Home range estimation methods for each gender and type of sightings. Analysis by paired t-tests.

Gender	Sightings Type	Home range methods being compared		DF	T-Value	P-Value	
Female	Combined	MCP	BN	48	-3.671	0.0006	
		MCP	90% Kernel		-3.712	0.0005	
	Random	BN	90% Kernel		-3.214	0.0023	
		MCP	BN	37	-2.895	0.0063	
	Telemetry	MCP	90% Kernel		-3.278	0.0023	
		BN	90% Kernel		-3.458	0.0014	
	Male	Compiled	MCP	BN	23	-4.614	0.0001
			MCP	90% Kernel		-4.420	0.0002
		Random	MCP	BN	46	-3.373	0.0015
			MCP	90% Kernel		-3.628	0.0007
Telemetry		BN	90% Kernel		-3.478	0.0011	
		MCP	BN	41	-3.384	0.0016	
All		Compiled	MCP	90% Kernel		-3.593	0.0009
			BN	90% Kernel		-3.335	0.0018
	Random	MCP	BN	10	-4.327	0.0015	
		MCP	BN	99	-5.059	<0.0001	
	Telemetry	MCP	90% Kernel		-5.182	<0.0001	
		BN	90% Kernel		-5.010	0.0033	
Random		MCP	BN	81	-4.212	<0.0001	
		MCP	90% Kernel		-4.529	<0.0001	
All	Compiled	BN	90% Kernel		-4.181	<0.0001	
		MCP	BN	37	-3.958	0.0003	
	Telemetry	MCP	90% Kernel		-4.740	<0.0001	

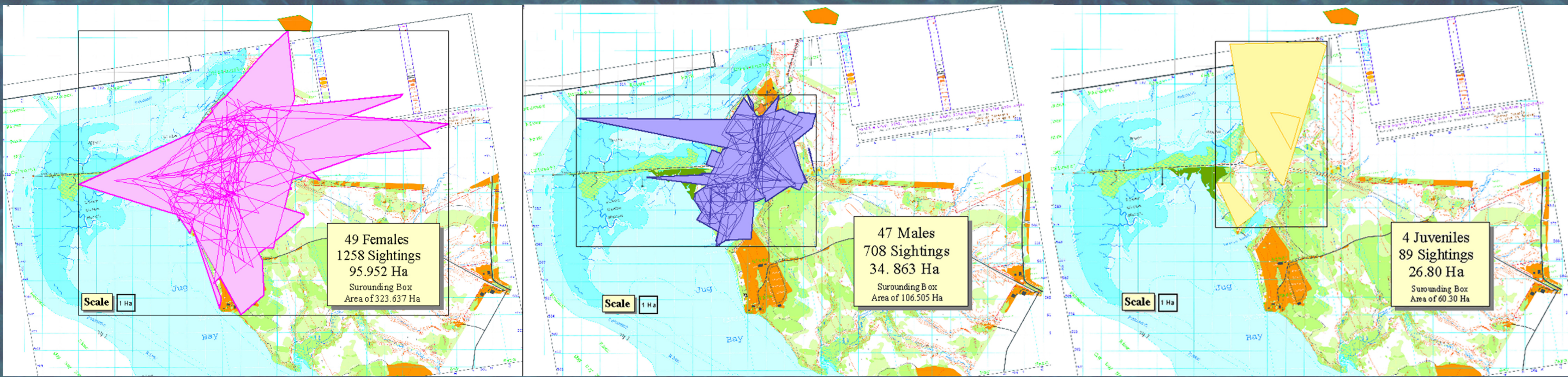


Fig. 6. Combined home ranges based on the Minimum Convex Polygon method. The home range of each individual turtle is depicted as a thin lined polygon; the total area used by each gender is depicted by a thick lined, shaded polygon.

DISCUSSION

Home Range.— Overall, the ranges were much larger than those reported elsewhere (Table 4). This may be due, in part, to our calculation of the entire home range instead of the “utilized home range” (Madden, 1975; Dodd, 2001). Another difference may be due to the large number of sightings used in our calculations. Stickel (1950) used turtles with 6 or more sightings (8 on average), whereas my study used turtles with 5 or more sightings (20.6 on average). Previous studies have suggested an inverse relationship between population density and home range size (Stickel, 1989). The large home ranges of the Jug Bay turtles would suggest that this area supports a small or low-density population. However, our ten-year, on-going study has documented a population of at least 455 turtles (as of May 2005), with a density of about 8 turtles per hectare (Swarth and Quinlan, unpublished). Box turtles are not territorial, so home ranges always overlap (Stickel, 1950; Dodd, 2001). Interestingly, despite the large home range size, the degree of overlap in our study area is much greater than in Stickel’s 1950 study (Fig. 7). The high density and large home range size that characterizes the Jug Bay population may be explained by Madden’s (1975) theory that high turtle densities in specific areas reflect the criticalness of that specific habitat. Meadows and wetlands are critical habitats for these turtles, especially for females.

Habitat Preference.— Unlike Strang’s 1983 study, significant preferences were found for the seven habitat types. While turtles were more abundant in upland habitats, it is clear that females occupy larger and more diverse areas than do males. This is due to the nesting requirements of females. Coinciding with their larger mean home ranges, females used more of each of the seven habitats than males; again due to nesting preparations which require that turtles travel large distances between the wetlands (where they may take on bladder-water or rehydrate after nesting) and meadows where they nest. It is important to note that while females may use tidal wetlands to a less than upland habitats, there is a strong observer bias making it more difficult to thoroughly survey wetlands because the marshes are dense, very muddy and difficult to walk through.

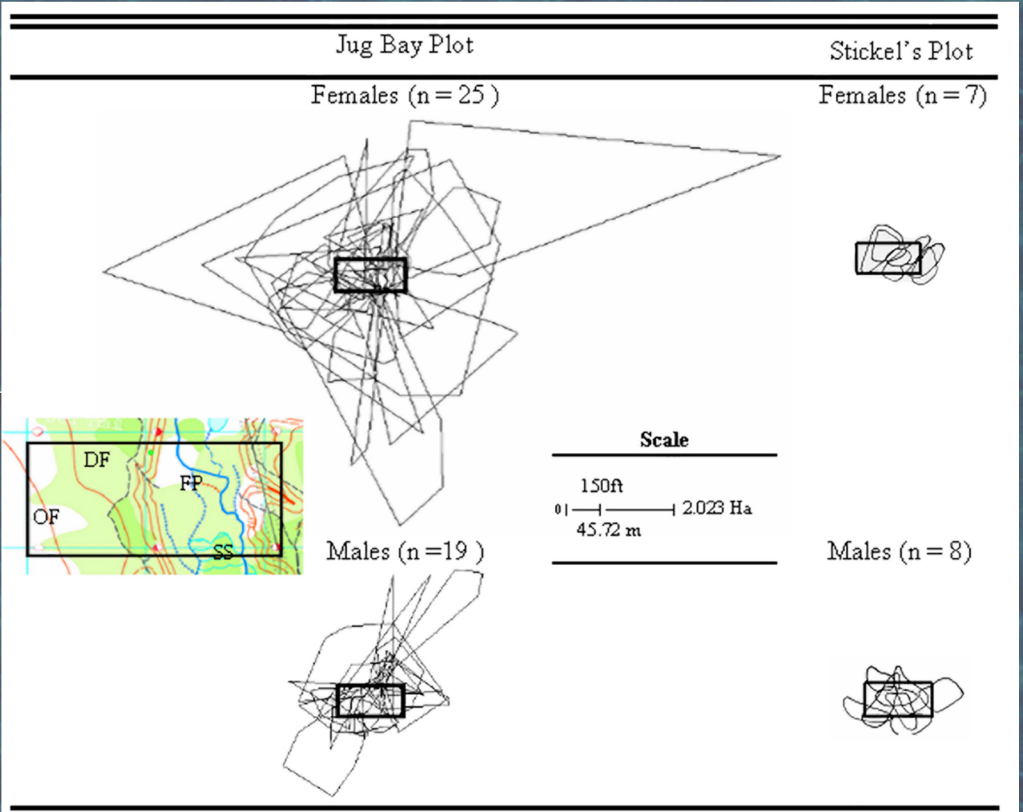


Fig. 7. Male and female MCP home ranges in a 5 acre (2.02 Ha) plot vs. the plotted areas of male and female turtles in the same size plot from Stickel’s 1950 study. Jug Bay MCP home range estimates were chosen for comparison because, while Stickel does not define the method used for her depicted home ranges, they appear to be smoothed MCPs. Stickel states that the 5 acre plot was chosen because it had the greatest degree of range overlap of any place in the study plot; for comparative purposes a 5 acre plot at Jug Bay with the most range overlap was chosen. Note that in each study the 5 acre plots are the same for males and females. Enlargement of the Jug Bay 5 acre plot is also depicted to show the 4 habitats found within it: Open Forest (OF), Dense Forest (DF), Flood Plain (FP), and Scrub Shrub (SS).

Conclusion

A conspicuous finding of this study is that females’ home range is significantly larger than that of males. This result has important conservation implications because larger, more diverse areas need to be protected to ensure population health. It is therefore dangerous to average male and female home ranges, as past research has done, because doing so risks the omission of crucial nesting habitats.

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