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Use of a Marked Population of Diamondback Terrapins (*Malaclemys terrapin*) to Determine Impacts of Recreational Crab Pots

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Diamondback terrapins (*Malaclemys terrapin*) are an important component of salt marsh ecosystems. Declines in population size have been reported from many areas throughout their range, from Massachusetts to Texas (Garber, 1990; Seigel, 1993; Seigel and Gibbons, 1995). Terrapin captures in commercial crab pots have been identified as contributing to the decline (Bishop, 1983; Roosenburg et al., 1997; Wood, 1997). Bishop (1983) estimated in South Carolina that there were 2835 terrapin captures in commercial pots per day in April and May with 10% mortality. Roosenburg et al. (1997) made population estimates for terrapins in Chesapeake Bay prior to conducting a study of mortality in crab pots. The study reported here for terrapins in the southern part of their range supports the finding that recreational crab pots are a potential conservation problem.

Methods. — A long-term mark-recapture study of diamondback terrapins in the Kiawah River, South Carolina, has resulted in the capture of more than 1200 adult terrapins since 1983 (Lovich and Gibbons, 1990; Tucker et al., 1995). Based on these data, population estimates were obtained for 1987–96 for a particular tidal creek, which allowed the number of terrapins captured in crab pots in this area in 1997–98 to be placed in a meaningful framework.

As Kiawah Island has developed, the number of recreational crabbers in the area has increased, while the commercial effort has remained constant (Joe Morris, commercial crabber, James Island, SC, *pers. comm.*). As the purpose of the current study was to assess the impact of recreational crab pots on terrapins, the locations and bait characteristic of recreational crabbing in South Carolina were utilized.

Fiddler Creek connects with the Kiawah River, which separates Kiawah Island from Johns Island, South Carolina, and is affected by tidal fluctuations of approximately 2 m. Depth in the study area at high tide ranges from 4 m at the mouth to 2.5 m in the upper reaches. Fiddler Creek is 21 m wide at the mouth, 8 m wide at the upper section, and is surrounded by marsh vegetation, primarily *Spartina alterniflora*.

Capture methods for the baseline long-term mark-recapture study from 1983–96 included trammel nets and seines during mid-ebb through mid-flood tides (Lovich and Gibbons, 1990; Tucker et al., 1995). Carapace length, plastron length, body mass, and age were recorded on all

captured terrapins, and each was uniquely marked by notching marginal scutes. Terrapins were returned to the same section of the creeks from which they were collected.

The present study was performed during two intervals, 1 May – 29 July 1997 and 1 April – 1 May 1998. Twenty recreational crab pots were set in Fiddler Creek. The pot entrances measured approximately 117 mm in width and 75 mm in height. Each pot was outfitted with a 13 mm diameter rebar weight along the bottom and was connected by 7 m of nylon rope to a 150 mm diameter styrofoam buoy. Pots were baited with raw chicken pieces (the bait most commonly used by recreational crabbers in the region) and set at approximately 33 m intervals along the center of the creek. Distance from shore ranged from 10 m near the mouth of the creek to 4 m at the upper section. The pots were monitored for 48 hrs each week and checked at 5-hr intervals during daylight hours to minimize the possibility of terrapin mortality. At the end of each 48-hr sampling period, the pot door was opened so terrapins would not be caught when the pots were not being monitored. All captured terrapins were identified, measured, and released at the capture site.

A Jolly-Seber population model (Pimentel, 1994), an open model designed for long-term studies, was used to estimate the terrapin population in Fiddler Creek based on the previously obtained baseline data. From 1987–96, 907 captures were made of 426 individuals. The data were analyzed by year.

Results. — During the 760 crab-pot-days in Fiddler Creek in 1997 and 1998, 21 captures were made of 19 individuals (= 0.027 terrapins per crab-pot-day). Two of the captures from 1998 were recaptures from the previous summer and were excluded from the analyses. Looking at the years separately, in summer 1997, 13 terrapins were captured during 600 crab-pot-days (Hoyle, 1997); in spring 1998, 8 terrapins were captured during 160 crab-pot-days. The sex ratio was 1 male to 1.4 females (8 males, 11 females). Nine individuals were unmarked. The mean plastron length was 109.3 mm for all terrapins captured (118.0 mm for females [range 96–152] and 99.6 mm for males [range 95–109]). All 8 males were sexually mature (>90 mm plastron length; Lovich and Gibbons, 1990). Only 2 of the 11 females were above the estimated size for sexual maturity (138 mm; Lovich and Gibbons, 1990). Two pots became entangled during a high spring tide during the 1997 season when they were not being monitored. Four terrapins entered these pots and died.

The estimated population size of terrapins in Fiddler Creek ranged from 168 to 299 for the years 1988–95 (Table 1). Based on the model used, the estimated annual recruitment of terrapins in Fiddler Creek during the period ranged from 12 to 79 individuals (Pimentel, 1994; Table 1).

Discussion. — In a population of 168 to 299 terrapins, the potential removal of 19 individuals represents 6–11% of the population. Assuming a best-case scenario of 299 individuals, the first summer of the study (not including the 4 terrapins drowned in the entangled pot) caught 4% of the total population.

Table 1. Population estimates of *Malaclemys terrapin* in Fiddler Creek, Kiawah Island, South Carolina, based on a Jolly-Seber model.

Year	No. Captured	No. Recaptured	Population Size Estimate (N)	95% Confidence Limits	Estimated No. of Recruits (B)
1987	7	—	233	150–551	79
1988	148	3	257	163–273	62
1989	68	30	299	221–305	35
1990	148	92	241	175–251	12
1991	148	92	241	152–261	30
1992	100	68	247	107–219	53
1993	81	62	235	66–346	
1994	72	50	170		
1995	22	12	168		
1996	36	22			

The funnel size of recreational crab pots combined with the demographics of the South Carolina terrapin populations results primarily in captures of mature males and immature females. Characterized by life history traits in which individuals are slow to mature and have extended longevity, terrapin populations cannot absorb chronic adult mortality (Congdon et al., 1994) caused by crab pots. In addition, in the Kiawah River populations, adult terrapins rarely move between creeks, thus reducing the likelihood of natural restocking of depleted areas (Gibbons et al., in prep.). Because of this strong site fidelity, anthropogenic mortality may have significant localized consequences on terrapin populations. In the Chesapeake Bay area, local terrapin populations can be extirpated in 3 to 4 years due to mortality in crab pots (Roosenburg et al., 1997).

Several differences in methodology between commercial and recreational crabbers suggest that recreational pots may be the greater threat to local terrapin populations. Recreational crabbers are able to access smaller creeks than commercial crabbers as they can wait for an appropriate tide to check their pots. Thus, recreational crabbers set their pots where terrapin populations are most concentrated. Commercial crabbers must be able to access their pots even at low tides because of the large number of pots they check in a day. In areas with high tidal amplitudes, as is characteristic of the Kiawah River, commercial crabbers cannot set their pots in the smaller creeks that are inaccessible at low tide. Additionally, recreational crabbers in South Carolina and Chesapeake Bay (Roosenburg, 1991) are more likely to leave their pots in the water for a longer period of time without checking them and may even unintentionally abandon them by placing them in areas where they can be washed away. The problem presented by lost pots was demonstrated by the two entangled pots in which four terrapins died. These pots were not being checked daily and represent the same threat as lost or ghost pots. In one year, two lost pots would account for more crab-pot-days than the 20 pots set during 1997.

In South Carolina, recreational crab pots presumably outnumber commercial pots. In 1997, the South Carolina Department of Natural Resources (SCDNR) licensed 277 commercial crabbers who set 20,552 pots. SCDNR estimates 25% of the 70,000 recreational fishermen licensed in

1997 set recreational crab pots. Two pots are allowed per person, resulting in a minimum estimate of 35,000 recreational crab pots in use in the state in 1997. This estimate does not account for recreational crabbers who do not fish and, therefore, do not require a license. The many tourists visiting Kiawah do not need licenses to set crab pots. Recreational crab pots may pose as big a threat to terrapin populations as commercial pots, because of the different methodology and higher number of pots used. Though recreational capture rates may not seem as high as the commercial rates reported by Bishop (1983), localized mortality from recreational pots can have a significant impact on a terrapin population.

In addition to local educational programs in coastal South Carolina where recreational crab trapping by inexperienced tourists is high, one solution for reducing mortality levels of diamondback terrapins is the use of some form of turtle excluder device, as recommended by Wood (1997). The use of a modified crab pot that is approximately 1.4 m taller than standard pots as recommended by Roosenburg et al. (1997), would not be effective in South Carolina tidal creeks due to the high tide amplitudes and strong currents. Although as yet untested, a simple pot design suggested by a commercial crabber would make the pot entrance a rectangular opening that is oriented vertically. Crabs would turn vertically to enter, whereas terrapins might not (Sinkey Boone, commercial fisherman, Darien, GA, *pers. comm.*). Whatever approaches prove to be most effective, the initial step is to provide convincing documentation that the use of recreational crab pots are exacting a high toll on America's only exclusively estuarine turtle.

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