Journal of Arid Environments 134 (2016) 62–65

Contents lists available at ScienceDirect

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv

Short communication

Movement patterns of soft-released, translocated Egyptian tortoises

Omar Attum [a,*], Basem Rabia [b]

[a] Department of Biology, Indiana University Southeast, New Albany, IN, USA
[b] Nature Conservation Sector, Egyptian Environmental Affairs Agency, Cairo, Egypt

ARTICLE INFO

Article history:
Received 22 September 2015
Received in revised form
14 December 2015
Accepted 1 July 2016
Available online 9 July 2016

Keywords:
Aestivation
Chelonians
Reintroduction
Testudo kleinmanni
Wildlife introductions

ABSTRACT

Dispersal from the release site and high mortality are two main factors that contribute to low retention of hard-released translocated wildlife. A soft-release translocation is a method that may increase the likelihood of translocation success because individuals are forced to acclimatize and become familiar to the new release site prior to the translocation. The objective of this study was to compare the movement patterns and retention rate of resident and translocated Egyptian tortoises that were translocated just prior to the start of the aestivation season and therefore were forced to aestivate at the release site (a forced in-activity soft-release). The retention rate of translocated tortoises, the proportion of tortoises that remained at the release site and alive by the end of the study, was 71% (5/7) compared to a retention rate of 100% for resident tortoises. There was no significant difference in the minimum convex polygon area, total distance moved, or the number of relocations during the activity season between resident and translocated tortoises. Our results suggest that a forced in-activity soft release consisting of translocating Egyptian tortoises just before the aestivation season may be effective in minimizing dispersal from the release site.

Wildlife translocations are increasingly being used as a method for the augmentation of declining populations, mitigating human-wildlife conflicts by removing animals away from the source of danger, and to restore once extinct populations (Kingsbury and Attum, 2009; Pinter-Wollman et al., 2009; Roe et al., 2008; Terhune et al., 2010; Yott et al., 2010; Nussear et al., 2012). Dispersal from the release site and high mortality are two important factors that contribute to low translocation retention, the proportion of individuals that survive and remain within the release site. Hard-release translocations, animals released without any prior acclimation or time spent at the release site, are less effective than soft-releases because hard-released animals are unfamiliar with the release site and often move more or have higher mortality than soft-released animals (Reinert and Rupert, 1999; Moehrenschlager and Macdonald, 2003; Tuberville et al., 2005; Kingsbury and Attum, 2009; Attum and Cutshall, 2015). A soft-release is when individuals are forced to spend time at the new release site prior to the translocation (Eastridge and Clark, 2001; Tuberville et al., 2005).

As the duration the animal spends at the release site prior to release increases, dispersal distance from the release site often decreases (Lohoefener and Lohmeier, 1986; Lockwood et al., 2005; Tuberville et al., 2005). Soft-releases can consist of animals placed inside an outdoor enclosure where the animal gains familiarity with the new site prior to release (Lockwood et al., 2005; Tuberville et al., 2005). Another soft-release method is a forced-inactivity soft-release in which the translocation occurs late in the activity season, just prior to hibernation, or when animals are already hibernating and are translocated into a new hibernaculum (Eastridge and Clark, 2001; Clark et al., 2002; Attum and Cutshall, 2015). A past study has shown that turtles translocated that were translocated just prior to the start of hibernation and thus forced to remain at the release site, had similar movement patterns as resident turtles (Attum and Cutshall, 2015). Presumably the need of translocated turtles to find a suitable hibernaculum may have overridden the tendency to disperse and forced the translocated turtles to be in-active for a long duration by spending time at the release site through hibernation (Attum and Cutshall, 2015).

The Egyptian tortoise *Testudo kleinmanni* is one of the smallest and most endangered tortoise species in the world, having the most restricted range of all tortoises in the Mediterranean Basin (Baha El Din et al., 2003). Habitat loss, fragmentation, and the illegal pet trade have led to dramatic declines in wild populations of *T. kleinmanni* over the last few decades. In Egypt, much of the Mediterranean coast has been altered by urban development and

* Corresponding author.
E-mail address: oattum@ius.edu (O. Attum).

http://dx.doi.org/10.1016/j.jaridenv.2016.07.001
0140-1963/

large-scale agriculture. Suitable Egyptian tortoise habitat in Egypt now exists only in a few protected areas (Baha El Din et al., 2003; Attum et al., 2007a).

Chelonians of arid lands have evolved in environments that experience long term, potentially lethal temperatures and low resource availability (Loehr et al., 2009; Barrows, 2011). Aestivation is an important strategy for Egyptian tortoises to survive prolonged periods of food reduction or unfavorable environmental conditions, such as high ambient temperatures or drought (Seidel, 1978; Hailey and Loveridge, 1997; Kennet and Christian, 1994; Roe et al., 2008). Egyptian tortoises typically aestivate or experience prolonged dormancy in the summer months, starting from the middle of May to early June until the end of September to the beginning of October – a period characterized by extremely high ambient temperatures, no rainfall, and the lowest food availability (Geffen and Mendelssohn, 1989; Attum et al., 2007b, 2008, 2013).

The objective of this study was to compare the movement patterns and retention rate of resident and forced inactivity soft-released Egyptian tortoises that were translocated just prior to the start of the aestivation season.

This study took place in Zaranik Protected Area (ZPA) in North Sinai, Egypt. ZPA is located 30 km west of the town El Arish (N 31° 05′, E 33° 25′), has an area of 250 km^2, an altitude range of sea level to 30 m, is characterized by stable and unstable sand dunes, and receives 50–100 mm rainfall per year. Perennial vegetation cover is between 5 and 10% and dominated by the shrub *Artemisia monosperma*.

The translocated tortoises originated from four localities in North Sinai, outside of the boundaries of ZPA. Private landowners notified ZPA staff of the tortoises location as they were concerned about mortality risk from the high levels of disturbance and upcoming land development. Some tortoises were collected at the end of the spring and translocated immediately to ZPA at the start of the aestivation season between the end of May and beginning of June. Tortoises in more immediate danger were temporally housed in a large outdoor enclosure (100 × 50 m) at ZPA for a few months prior to the translocation.

Radio transmitters, approximately 4 g, were glued onto the carapace with an epoxy and attached to eight resident (5 females and 3 males) and seven (5 females and 2 males) translocated adult tortoises. We do not have the weights and measurements for some tortoises because of equipment failure in the field. The mean + SE carapace length and weight was 110 + 5 mm and 206 + 36 g for female (n = 2) and 89 + 1 mm and 124 + 9 g for male resident tortoises (n = 2). Translocated female tortoises measured 109 + 1 mm and 175 + 0 g (n = 2), and a translocated male tortoise (n = 1) measured at 90 mm and 112 g. The resident tortoises were captured at the release site during the translocation process.

We tracked the movement of three translocated and four resident tortoises between May 2010 until the political unrest at the end of January 2011. We tracked the movement of an additional four translocated and four resident tortoises between May 2012 and April 2013. For every tortoise location, we recorded the latitude and longitude coordinates, date, time, behavior, and the species and canopy diameter of shrubs used as refuge. All tortoises we located once per week.

We calculated the movement patterns, minimum convex polygon (MCP) area and total distance moved, of translocated and resident tortoises during the activity season using GIS software. We calculated the aestivation duration in days, the number of movements between shrubs during the aestivation season, and the total distance moved during the aestivation season. The beginning of the aestivation season was defined by three consecutive tortoise relocations under the same shrub starting from the end of May or beginning of June. The aestivation season was considered over once there was three consecutive use of different shrubs between the end of September or beginning of October. During the aestivation season, tortoises occasionally made short movements and utilized a different shrub. We the compared the mean canopy diameter of shrubs used by resident and translocated tortoises during the aestivation season. If a tortoise used the same shrub multiple times, we only used one measurement per shrub in the analysis. We used multiple one way ANOVAs for statistical comparisons between treatments. We combined the sexes for each treatment to increase our sample size.

One translocated female tortoise never aestivated, utilizing a different shrub for each relocation during the summer. This female was found dead at the end of the study on April 1, 2013 with two eggs. This individual was not included in the analysis of aestivation parameters. In addition, we were unable to locate a translocated female six months after translocation for unknown reasons. The retention rate, the proportion of tortoises that remained at the release site and alive by the end of the study, was 100% for residents and 71% (5/7) for the translocated tortoises. Resident tortoises were relocated 31.9 + 1.4 SE times and translocated tortoises were relocated 30.3 + 2.4 times.

There was no significant difference in the MCP area (ANOVA: $F_{1,13} = 0.13$, $P = 0.72$), total distance moved (ANOVA: $F_{1,13} < 0.001$, $P = 0.98$), or the number of relocations (ANOVA: $F_{1,13} = 0.35$, $P = 0.57$) during the activity season between resident and translocated tortoises (Fig. 1). There was no significant difference between resident and translocated tortoises regarding aestivation duration (ANOVA: $F_{1,13} = 0.21$, $P = 0.65$), the number of movements between shrubs (ANOVA: $F_{1,13} = 0.60$, $P = 0.45$), and the total distance moved during the aestivation season ($F_{1,13} = 0.97$, $P = 0.34$; Fig. 2). We also found no significant difference in the shrub diameter used by resident and translocated tortoises during the aestivation season (ANOVA: $F_{1,13} = 0.70$, $P = 0.42$; Fig. 2).

Our results suggest that a forced in-activity soft release consisting of translocating Egyptian tortoises just before the

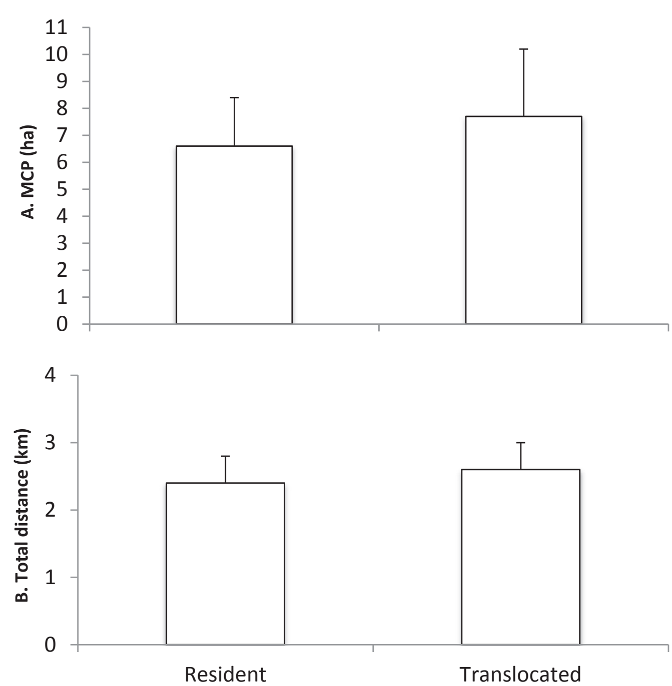

Fig. 1. Movement parameters (mean + SE) of resident and translocated Egyptian tortoise during the activity season. A. MCP = minimum convex polygon area (ha). B. Total distance = total distance moved (km).