BIOLOGICAL CONSERVATION 135 (2007) 247–255

available at www.sciencedirect.com

ScienceDirect

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

Island differences in population size structure and catch per unit effort and their conservation implications for Komodo dragons

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ARTICLE INFO

Article history:
Received 1 June 2006
Received in revised form
12 October 2006
Accepted 15 October 2006
Available online 4 December 2006

Keywords:
Varanus komodoensis
Komodo dragon
Islands
Population divergence
Conservation implications

ABSTRACT

Species inhabiting archipelagos are often characterised by high levels of interpopulation divergence (e.g. size related traits). This divergence may, in turn, influence their life-history. To facilitate better management and conservation of the Komodo dragon (*Varanus komodoensis*), an island endemic, we identified demographic differences between two island populations in Komodo National Park, Indonesia. Comparison of data collected from dragon populations inhabiting Rinca Island and the much smaller Gili Motang Island indicated that between 1994 and 2004, the Komodo dragon population on Gili Motang significantly decreased its: (1) mean body mass, (2) body condition and (3) relative abundance. These results suggest that the numerically small Gili Motang population was oscillating downwards; in contrast, the Rinca Island population had been relatively stable. More importantly these results emphasize the necessity for managers of this priority conservation species to understand further the inherent functional differences among dragon populations to develop island specific management units. Current management practices (e.g. monitoring) instigated by Komodo National Park management ignore small island dragon populations and thus run the risk of being unable to detect adverse effects for populations that are potentially most prone to decline.

1. Introduction

Species inhabiting archipelagos are often distributed on multiple and variable island land masses exhibiting heterogeneity in environment and community structure (MacArthur and Wilson, 1967). This environmental variation, along with the relative degrees of isolation facilitates evolutionary and ecological processes that are responsible for often significant levels of population divergence leading to both increased endemism and biodiversity associated with archipelagos (Grant, 1998). However, insular species are particularly susceptible to threatening processes including habitat loss, harvesting and invasive species because they are isolated and occur on smaller land masses (Reid and Miller, 1989; Burkey, 1995). In addition the demographic and genetic quality of island populations often facilitates their susceptibility to threats (Frank-

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0006-3207/$ - see front matter
doi:10.1016/j.biocon.2006.10.025

ham, 1998). Combined, such processes have led to, or are expected to contribute to, much greater rates of extirpation or extinction in island vertebrates compared to continental forms (Diamond, 1989; Case et al., 1992; Cardillo et al., 2006).

Consequently managing island endemics for conservation is a high priority particularly in tropical archipelagos where both diversity and threatening processes are greatest. However, even within a single endemic, which in archipelagos can be represented by disjunct populations distributed across multiple islands, conservation can be complicated by divergence in organismal traits that can lead to different impacts (i.e. from threatening processes) among populations. For example, when exposed to natural perturbations such as El Nino, which can dramatically reduce food availability, birds and lizards occupying different islands in the Galapagos archipelago may vary in their susceptibility to mortality and the degree to which their independent populations decline (Wikelski and Trillmich, 1997; Grant, 1998). In essence, this variation in a population's decline reflects respective differences in life-history traits underpinning population dynamic processes. Subsequently, the capacity to detect intraspecific differences in population dynamics would seem essential to conserving island endemics and particularly necessary for delivering demographic based wildlife-management strategies to mitigate specific threatening processes (Caswell et al., 1999). Despite the application of population dynamic studies for guiding the conservation and management of species, there are few comparisons between multiple populations of the same species living among islands (Coulson et al., 2005), especially for species of high conservation value.

The Komodo dragon (*Varanus komodoensis*) is a large and robust species of monitor lizard endemic to five islands in south-east Indonesia (Auffenberg, 1981; Ciofi and De Boer, 2004). At present, data pertaining to the demography of this species is largely absent (Auffenberg, 1981; Jessop et al., 2004). Variation in population dynamics, manifested as temporal differences in survival and fecundity among island populations could be promoted in response to differences in island-specific evolutionary and ecological processes. Across its restricted range, this large predator maintains populations on islands ranging in area from approximately 10 km^2 up to 6000 km^2 (Ciofi and Bruford, 1999). Existing studies indicate that there are significant differences among populations with respect to population genetics and morphology, particularly between large and small island populations, reflecting dispersal capacity and resource dynamics (Ciofi and Bruford, 1999; Jessop et al., 2006). However, despite these examples of interpopulation divergence, there is little functional evidence for how the populations vary demographically over time, a crucial indicator of overall population status. In this preliminary study we investigated the potential for insular differences in the temporal population dynamics of dragons in Komodo National Park. This World Heritage protected area contains four extant populations distributed across two large and two small islands. Using a comparison between one small island (Gili Motang) and one large island (Rinca) we examined demographic differences in these two populations over a 10 year period. If insular differences exist, then management of insular meta-populations of *V. komodoensis* will need to consider island (i.e. population) specific conservation measures. By adopting a fisheries type approach used in stock assessment, we evaluated changes in morphological and catch per unit effort (from trapping) to make inferences about the temporal dynamics of Komodo dragon populations inhabiting the islands of Gili Motang and Rinca. We compared data collected from this population in 1994 to complementary data collected annually in 2002, 2003 and 2004.

Specifically, we assessed whether the Gili Motang and Rinca populations could be described as stable, or oscillating, and whether they exhibited concordance in their dynamics over the time period between 1994 and 2004 by assessing differences in five parameters—(a) size frequency distributions, (b) mean snout–vent length (SVL) and mass, (c) body condition, (d) relative population abundance derived from catch per unit effort data and (e) abundance estimates of the Gili Motang population in 2004.

Frequency differences in body size distributions over time could indicate relative changes in survivorship, recruitment and migration. Temporal changes in body condition might indicate the populations health influenced by such factors as food availability, disease or parasitism. Differences in catch per unit effort could provide an indication whether the population numbers are rising, falling or stable. An estimate of population abundance, on a small isolated island, could provide a rough gauge for assessing the theoretical extinction proneness of the Gili Motang dragon population. Collectively, temporal differences in these parameters between islands could provide the first insights into potential differences in the dynamics and thus status of populations of the Komodo dragon populations, a species of unparalelled national status and high conservation value in Indonesia.

2. Methods

This study was undertaken on Komodo dragon populations on the islands of Rinca (278.0 km^2) and Gili Motang (10.3 km^2) in Komodo National Park in the Lesser Sunda region of South-eastern Indonesia (Fig. 1). Within Rinca, four study sites were selected and subsequently combined to represent a total island sample in which to assess inter-island population variation and included the valleys of Loh Buaya, Loh Baru, Loh Tongker and Loh Dasami (Fig. 1). On the small mountainous island of Gili Motang, field work was confined to the coastal flats and adjacent hills representing approximately 20% of available island habitat. The primary study area on this island consisted of a triangular shaped wedge, 2.1 km^2 in area, on the north-west side of the island. Outside this core study area a number of randomly positioned trapping sites were used to verify that our trapping area provided a representative population sample. Field work for this study consisted of four trapping sessions (8–14 days duration per site); first in 1994 as part of a population genetic study, and then again annually from 2002 through to 2004 during routine population monitoring within Komodo National Park. All field work was conducted in August/September during the mid dry season to standardise capture protocols. Trapping sites in the 2002–2004 period incorporated those sites used in the 1994 sampling period providing an overlapping sampling regimen.

Komodo dragons were captured in 300 cm × 50 cm × 50 cm long box traps (N = 4–8 traps) baited with goat meat (≈0.5 kg)