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Counting and measuring ghost crab burrows as a way to assess the environmental quality of beaches

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ABSTRACT

Despite controversies, the non-destructive indirect method of counting and measuring the burrows of ghost crabs remains the best option for assessing the environmental quality of beaches. In order to better conserve and manage local populations and their environments, we evaluated the occurrence of the ghost crab *Ocypode quadrata* at 39 beaches, characterized according to the degree of human presence and by physical factors. Three main groups of beach variables-low, moderate and high – were identified according to the degree of human presence coupled with natural factors. The modes of access and cleaning best discriminated the beaches. Amongst physical features, only "trail beaches" and "restricted access beaches" significantly differed from other beaches. The drift and effluent beach zones with lesser human presence showed the highest numbers/densities of burrows. Older crabs, inferred by the largest burrows, were found less frequently at all beaches, the drift zone being the major aspect for their presence. Despite the great variability in the distribution of ghost crabs, they are sensitive to low environmental quality and their adequacy for assessing environmental quality was confirmed.

1. Introduction

The conservation of natural ecosystems has become a scientific, government, and management issue since humans perceived the value of natural capital (Paoli et al., 2016). Natural capital includes all living things that are increasingly suffering direct or indirect effects from human exploitation and natural resource use.

The reduction or local extinction of natural populations from sandy beaches as a consequence of removal of habitat, human trampling and vehicular traffic, among other factors, is an increasing risk nowadays (Brown and McLachlan, 2002). Haphazard planning and development of coastal regions (Brambati, 2004), as well as poor environmental awareness amongst visitors (Priskin, 2003; Pendleton et al., 2001), contribute to a state of enhanced environmental risk for beaches (Santos et al., 2005). Since beaches frequently are not recognized by the public as truly natural environments, structured by a unique flora and fauna (Brown and McLachlan, 2006), their deterioration often occurs unnoticed (Jedrzejczak, 2004).

In the face of the increasing threats beaches are suffering worldwide, conservation and management efforts are necessary in order to preserve the ecosystem goods and services they provide for humankind, manly for urban beaches where environmental problems are exacerbated. However, adequate conservation and management practices for beach ecosystems require a solid scientific knowledge in order to avoid using inappropriate approaches. An understanding of structure and functioning, and the responses of ecosystems to the stressors they face is highly desirable (Nel et al., 2014). According to Schlacher et al. (2016), a considerable part of the knowledge necessary for implementation of management plans must be based on the response of the biota to anthropogenic impacts.

Indiscriminate exploitation of beach ecosystems (Defeo et al., 2009) is facilitated to some degree by beach managers who exercise limited action to protect these environments (Lucrezi et al., 2016; Gelcich et al., 2009). According to Lucrezi et al. (2016), for beaches that are managed, management is based on standard approaches, using information from one or a few features of the beach

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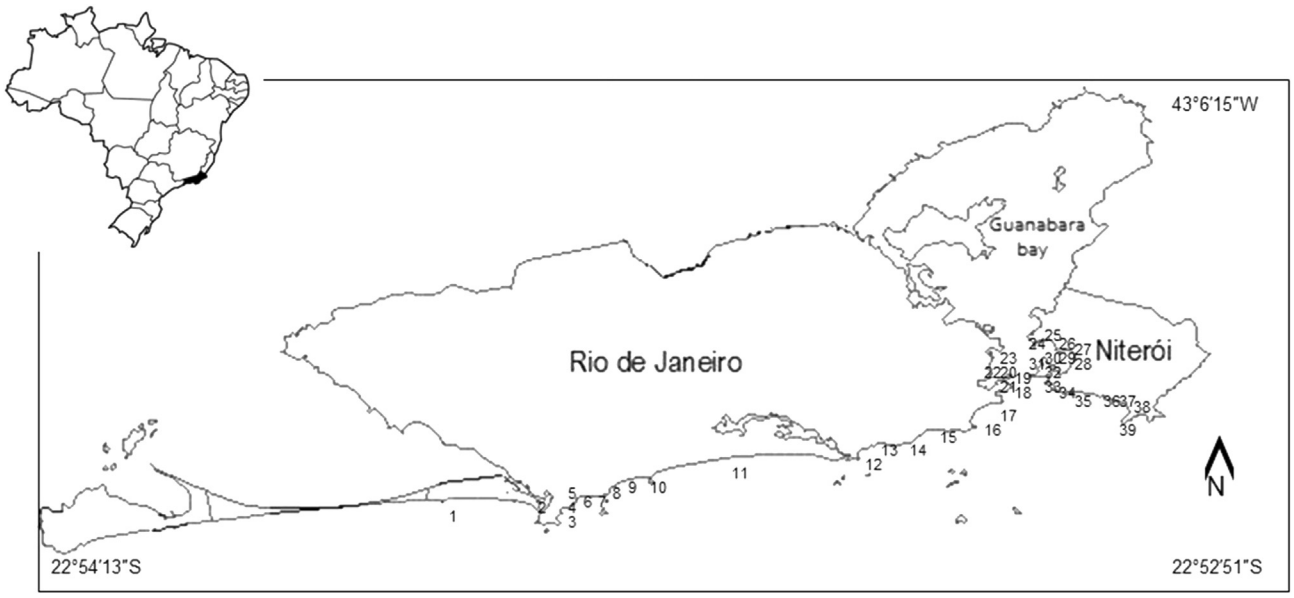

1	Marambaia (Mar)	9	Macumba (Mac)	17	Copacabana (Cop)	25	Flexas (Fle)	33	Forte Imbuí (Fim)
2	Inferno (Inf)	10	Cto Recreio (CRe)	18	Vermelha (Ver)	26	Icaraí (Ica)	34	Piratiniqa prainha (Ppr)
3	Funda (Fun)	11	Barra (Bar)	19	Forte Urca fora (FUF)	27	São Francisco (SFr)	35	Piratininga (Pir)
4	Meio (Mei)	12	São Conrado (Sco)	20	Forte Urca dentro (FUD)	28	Charitas (Cha)	36	Sossego (Sos)
5	Perigoso (Per)	13	Joatinga (Joa)	21	Urca (Urc)	29	Jurujuba (Jur)	37	Camboinhas (Cam)
6	Guaratiba (Gua)	14	Sheraton (She)	22	Botafogo (Bot)	30	Adão (Ada)	38	Itaipu (Ita)
7	Grumari (Gru)	15	Ipanema (Ipa)	23	Flamengo (Fla)	31	Eva (Eva)	39	Itacoatiara (Itc)
8	Prainha (Pra)	16	Diabo (Dia)	24	Boa Viagem (BVi)	32	Forte Rio Branco (FRB)		

Fig. 1. Location of the 39 studied beaches from two cities of Rio de Janeiro state (Rio de Janeiro and Niterói), southeastern Brazil.

environment or using inconsistent methods regarding conservation issues. Adopting standard approaches may ignore important features of local beaches and undesirable effects could be attained. Implementation of management actions should be based on scientific knowledge of local ecosystems to avoid inappropriate practices.

Ghost crabs (Genera *Ocypode* and *Hoplocypode*) are appropriate species for studying anthropogenic impacts on beach ecosystems. They are widely distributed throughout the tropics and subtropics and are found in different types of beaches; they are large and species are easy to identify; their abundance is frequently high; and the openings of their burrows are conspicuous and could be used as proxies of their presence, abundance and length (Schlacher et al., 2016). The indirect non-destructive method of counting and measuring the burrows of ghost crabs has been widely utilized in studies of their ecology (Wolcott and Wolcott, 1984; Barros, 2001; Turra et al., 2005; Schlacher et al., 2011). This method is feasible as long as there is a good correlation between carapace width and the width of burrows (Wolcott, 1978; Branco et al., 2010; Oliveira et al., 2016). However, some authors claim a discrepancy exists between the occurrence of burrows and the presence of crabs (Pombo and Turra, 2013; Silva and Calado, 2013), and issues regarding the impermanence of burrows over time have been raised (Lucrezi et al., 2009). Despite these

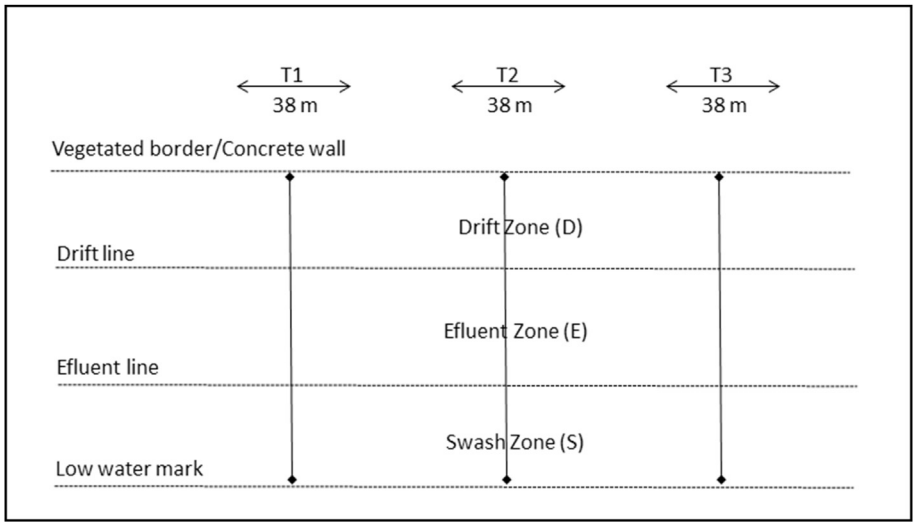

Fig. 2. Scheme of the sampling design adopted.