Short communication

Use of riverine through reef habitat systems by dog snapper (*Lutjanus jocu*) in eastern Brazil

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**A R T I C L E   I N F O**

Article history:
Received 26 April 2010
Accepted 5 August 2011
Available online 17 August 2011

Keywords:
reelfish
habitat use
cross-shelf
connectivity
ontogenetic migrations
mangroves

**A B S T R A C T**

The early life history of Western Atlantic snappers from the Southern hemisphere is largely unknown. Habitat use of different life stages (i.e. size categories) of the dog snapper (*Lutjanus jocu*) was examined across the largest South Atlantic reef–estuarine complex (Abrolhos Shelf, Brazil, 16–19°S). Visual surveys were conducted in different habitats across the shelf (estuary, inner-shelf reefs and mid-shelf reefs). *Lutjanus jocu* showed higher densities on inner-shelf habitats, with a clear increase in fish size across the shelf. Individuals <7 cm were associated with both the estuary (mangrove and rocky habitats) and inner-shelf reefs (particularly shallow fore-reefs and tide pools). Individuals ranging 10–30 cm were broadly distributed, but consistently more abundant on inner-shelf reefs. Individuals between 30 and 40 cm were more common on mid-shelf reefs, while individuals >40 cm were recorded only on mid-shelf reefs. Literature data indicate that individuals ranging 70–80 cm are common on deep offshore reefs. This pattern suggests that the dog snapper performs ontogenetic cross-shelf migrations. Protecting portions of the different habitats used by the dog snapper during its post-settlement life cycle is highlighted as an important conservation and management measure.

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1. Introduction

Adult snappers (Lutjanidae) typically associate with rocky and coralline habitats, comprising one of the most important reef fisheries resources in the Western Atlantic. In Northeastern Brazil, snappers represent a conspicuous component of reef fish assemblages (Moura and Francini-Filho, 2005; Francini-Filho and Moura, 2008a) and a primary constituent of artisanal reef fisheries (Frédou et al., 2009a, b). The lutjanid fauna of the tropical and warm temperate South Atlantic (Brazil) contains 19 species, all but one shared between the Caribbean and Brazil (Moura and Lindeman, 2007). The dog snapper, *Lutjanus jocu*, is one of the five most important lutjanids in the Brazilian reef fishery, with landings estimated at 3000 t/y (Frédou et al., 2009a, b). Despite its commercial importance and wide distribution (Florida to South-eastern Brazil) there is little information on the biology and ecology of *L. jocu* in comparison to other Western Atlantic snappers (Claro et al., 2001; Rezende and Ferreira, 2004).

Coastal habitats such as mangroves, seagrass beds and estuaries are recognized as important nurseries for many reef fish species (Parrish, 1989; Adams et al., 2006). They may offer the benefits of lower predation risk and higher food availability for small fish, which may latter migrate offshore with increasing age and size (Blaber and Blaber, 1980; Verweij et al., 2006; Nagelkerken, 2009). Evidences of such ontogenetic shifts in habitat use come from direct observations in the field (e.g. Verweij et al., 2007) or are inferred from: 1) size-frequency distribution of fishes on different cross-shelf habitats (e.g. Appeldoorn et al., 1997; Nagelkerken et al., 2000a, b), 2) comparison of fish abundance in reefs far and close to nursery habitats (e.g., Dorenbosch et al., 2005, 2007) and 3) comparison of islands with or without coastal nursery habitats (Nagelkerken et al., 2002; Mumby et al., 2004).
The Abrolhos Shelf (45,000 km²) is the largest and most biodiverse reef system in the South Atlantic, also encompassing a mosaic of algal and muddy bottoms, estuarine mangroves and beaches (Dutra et al., 2005). Although detailed information on several aspects of reef fish ecology is accumulating (e.g. Francini-Filho and Moura, 2008a, b; Moura et al., 2009), information on the scales of movements of individuals, from larvae to spawning stages, is still lacking. In particular, no information on settlement for the most important fishery species is available.

Here, the distribution and abundance of different life stages of the dog snapper was studied across the Abrolhos Shelf. This type of information is scarce even for the Caribbean, where little is known about dog snapper early life history. Size-frequency distributions across the shelf were used to identify patterns in habitat use and the possible occurrence of cross-shelf ontogenetic migrations. The main objective here is not to evaluate the effects of different management regimes, as this information is available elsewhere (Francini-Filho and Moura, 2008a).

2. Methods

2.1. Study area

The Abrolhos Shelf (16° 40′–19° 40′S, 39° 10′–37° 20′W) is a relatively shallow (<50 m depth) and extensive (200 km at its widest portion) area of the eastern Brazilian coast (Martins and Coutinho, 1981) (Fig. 1). A large estuarine complex (Caravelas-Nova Viçosa) and other smaller estuaries near river mouths (Bur-anhém, Frades, Jucuruçu and Mucuri) are major inshore features of Nova Viçosa) and other smaller estuaries near river mouths (Bur-anhém, Frades, Jucuruçu and Mucuri) are major inshore features of

2.2. Survey methods

Three to six sites were sampled within each of the three cross-shelf strata (Fig. 1). Samples were obtained along the year between March 2008 and March 2009, based on weather conditions and on quarter moon tides (when water visibility is greater within the estuary). Visual surveys (20 × 2 m transects) were used to quantify fish abundance. Transects were positioned parallel to the reef front and adjacent to prop roots and downed trees or rocks. Three to 18 haphazardly located replicates were obtained per site per season. Fish lengths were estimated considering the nine following size categories: <1, 1–3, 3–5, 5–7, 7–10, 10–20, 20–30, 30–40, >40 cm (total length, TL). Extensive training in fish size estimation was undertaken with use of fish models prior to sampling (Samoilys, 1997).

2.3. Data analysis

Analyses of variance (ANOVA) were used to evaluate spatial (cross-shelf strata and sites) and temporal (seasonal) variations in

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Fig. 1. Map of the Abrolhos Shelf, eastern Brazil, showing the study areas and marine protected areas. A – Estuary (sites 1–3), B – Parcel das Paredes Reef (site 4), C – Sebastião Gomes Reef (sites 5–9), and D – Abrolhos Archipelago (sites 10–12).
fish density, with sites nested within cross-shelf strata. Additional one-way ANOVA were performed in order to clarify small-scale patterns in fish abundance (e.g. between-sites differences within a given strata). Normality and homocedasticity were obtained by converting fish density to Log \( x + 1 \). Student-Newman-Keuls (SNK) multiple comparisons of means were performed as post-hoc tests. Size distributions of fishes between cross-shelf strata were compared using the Kolmogorov–Smirnov two-sample test (Zar, 1999). One-way analysis of similarities (ANOSIM) was used to evaluate whether variability in abundance of different size classes of the dog snapper was more strongly associated to space (i.e. between-strata differences) or time (between-seasons) (Clarke and Warwick, 1994).

3. Results

Total density of *L. jocu* was highest on inner-shelf reefs, followed by the estuary and mid-shelf reefs, although there was no significant difference between the latter two strata (SNK post hoc, \( p > 0.05 \)). There was a clear increase in fish size across the shelf. Individuals <7 cm were almost exclusively associated with the estuary, whereas fishes >40 cm were recorded only on mid-shelf reefs. Individuals ranging from 10 to 30 cm were most abundant on the inner-shelf reefs (Fig. 2) (Table 1). Significant differences in size structure were detected by the Kolmogorov–Smirnov test (\( p < 0.05 \) between all pairs of cross-shelf strata with a clear increase in fish size from the estuary to mid-shelf reefs (Fig. 3).

![Fig. 2. Spatial patterns in density (mean ± SE) of different size categories of *Lutjanus jocu*. Sites are numbered according to Fig. 1. One-way ANOVA results: *\( P < 0.05 \), **\( P < 0.01 \), ***\( P < 0.01 \), ns = not significant. Homogeneous groups, as determined by Student-Newman-Keuls (SNK) post-hoc comparisons, are linked by equal letters. Note scale differences on y axes.](image-url)
Dog snapper density varied among sites within two of the cross-shelf strata. In the estuary, the smallest size class (<1 cm) was recorded exclusively at site 1 (Rhizophora/downed tree habitat), whereas site 3 (rocky habitat) harboured the highest total density, with particularly high abundances of individuals ranging from 7 to 20 cm. At the inner-shelf, density was highest at the Sebastião Gomes Reef, with most individuals ranging from 10 to 30 cm and 20 cm. At the inner-shelf, density was highest at the Sebastião with particularly high abundances of individuals ranging from 7 to 20 cm size class (up to 500 fish.1000 m⁻²) in the pool of site seven (see Figs. 1 and 2). No significant differences in fish density were detected among sites within the mid-shelf reefs, the only stratum where individuals >40 cm were present and no individuals <10 cm were recorded (Fig. 2).

Significant seasonal variations in fish density were only detected for the 5–20 cm size class and for total fish density (Table 1). In general, spatial effects were clearly more important than temporal ones when considering the multivariate structure in size of L. jocu (between-seasons ANOSIM: \( R = -0.07, p = 0.65 \); between-strata ANOSIM: \( R = 0.21, p = 0.01 \)).

### 4. Discussion

Not all estuarine communities and mangrove habitats may function as nurseries (e.g., Chittaro et al., 2005; Dahlgren et al., 2006). Depending on the species and location, evidence supports high (e.g., Mumbuy et al., 2004), low (e.g., Dorenbosch et al., 2005) and variable (Lindeman et al., 1998) dependence of reef fishes on estuaries. On the Abrolhos Shelf, estuarine mangroves and rocks, as well as inner-shelf reefs, showed relatively high densities of newly settled and juveniles of the dog snapper, suggesting a nursery role. The pattern of cross-shelf increase in fish size recorded here, together with indications from fishery data for high abundances of large dog snapper individuals (70–80 cm TL) on deep reefs (Freitas et al., 2011), support the hypothesis that in the Abrolhos region the dog snapper perform cross-shelf ontogenetic migrations.

Compared to the Caribbean, seagrass beds are much less abundant and structured throughout the South Atlantic (Creed, 2003). As shown by the lack of L. jocu in our surveys of seagrasses and their role of seagrass habitats of the Brazilian coast (composed mainly by shortbladed Halodule and Halophila) appears less significant than that of the Thalassia and Syringodium beds that are widespread in the Caribbean. Although dog snapper individuals with <3 cm TL have been collected from mixed seagrass beds in southeast Florida (Lindeman et al., 2006), the early life history of this species in the greater Caribbean remains poorly known.

Sites with rocky habitats within the Caravelas-Nova Viçosa estuary showed higher densities and larger individuals of L. jocu than sites with downed trees and Rhizophora. This pattern suggests that some individuals may display stepwise migrations (cf. Cocheret de la Morinière et al., 2002), moving between sites within the estuary and then to inner and mid-shelf reefs with increased size.

Fish species that use structurally complex shallow coastal habitats as nurseries increase mobility and may emigrate offshore as size increases and the efficacy of protection provided by shallow shelter decreases (Nagelkerken et al., 2000a; Adams et al., 2006). Fishes may also change their habitat requirements when they reach sexual maturity (Verweij et al., 2007). Sexual maturity of L. jocu in the Abrolhos Bank is attained at about 32 cm for females and 34 cm for males (Freitas et al., 2011), similar to conspecifics from the Caribbean (Claro et al., 2001). The modal sizes of dog snappers migrating from the estuary to inner-shelf reefs and from inner-shelf reefs to mid-shelf reefs are 10–20 and 30–40 cm TL, respectively (see Fig. 2; Cocheret de la Morinière et al., 2002). Thus, aspects of the reproductive cycle of L. jocu may work as triggers for habitat shifts during the cross-shelf migration process.

Information on the early life history of western Atlantic lutjanids and other commercially-important reef fishes is largely unknown from the Southern Hemisphere, constraining the identification and protection of critical settlement and nursery habitats, migration corridors and spawning areas in the Abrolhos Bank, coastal areas are threatened by overfishing, escalating human development, seaport construction, and dredging. Thus, it is urgent to identify and protect portions of the different cross-shelf habitats used by
important fishery species, such as the dog snapper, during their entire post-settlement life cycle.

Acknowledgements

We thank L. Kaufman, M.O. Freitas and B.P. Ferreira for comments and advice on the research; G.F. Dutra, D.L. Araújo, E.C.O. Coni, P.M. Meirelles, R.M. Reis and C.M. Ferreira for field and administrative assistance. Parque Nacional Marinho dos Abrolhos and Reserva Extrativista de Cassurubá/ICMBio for logistical support and research permits. A Doherty Fellowship in the Dept. of Marine and Environmental Systems, F.I.T., assisted completion of components of this work. This is a contribution of Conservation International’s Marine Management Areas Science Program.

References


