Appendix S1. List of benthic marine non-native fauna in the state of Paraná.

Here we discuss in more detail the current situation of NIS and cryptogenic species in the state of Paraná and comment previous records.

There are also some NIS that were not found in Paraná waters, but deserve special attention, such as the cup corals *Tubastraea coccinea* Lesson, 1829 and *Tubastraea tagusensis* Wells, 1982, which occur in both neighbor states of São Paulo and Santa Catarina (LOPES 2009, MANTELLATO et al. 2011). These species may occur in massive abundances and reduce local biodiversity by competing with native species (CREED 2006). Another species of concern is the ascidian *Ciona robusta* Hoshino & Tokioka, 1967 (former *C. intestinalis* sp. A), probably the species present in São Paulo (ROCHA & BONNET 2009) and Rio de Janeiro (MARINS et al. 2009). Although it is still very rare in Brazil, in other places of the world it can be abundant, reduce the biodiversity and change species composition in sessile communities (BLUM et al. 2007). This ascidian can also impact species of commercial importance, like mussels and oysters (RAMSAY et al. 2008).

Below, we discuss the NIS within each of the taxonomical groups present in the research area:

**Ascidians**

Although the official list of introduced species of Brazil brings only two ascidians (*Ascidia sydneiensis* Stimpson, 1885 and *Styela plicata* (Lesueur, 1823)) (LOPES 2009), five non-native ascidians occur in Paraná. *Ascidia sydneiensis* has been first recorded at Galheta island (ROCHA & KREMER 2005), and now in artificial reefs located offshore. *Styela plicata* is usually found in artificial substrates near harbor areas and associated with bivalve aquaculture (LOPES 2009). Indeed, in Paraná the species was found on artificial substrata in Guaratuba Bay, but also on rocky substrata of Mel island (ROCHA & KREMER 2005), which is under direct influence of PEC. Although, it is abundant and considered invasive in other regions of the Brazilian coast, in the present survey it was found in only one site of natural substrata inside PEC.

*Ascidia tenue* (Monniot, 1983) and *Sidneyoides peregrinus* Kremer, Metri & Rocha, 2011 have been recorded only once, the former on artificial substrata located offshore (BUMBEER & ROCHA 2012) and the latter underneath rocks inside PEC (KREMER et al. 2011).

*Clavelina oblonga* Herdman, 1880 was the most spread ascidian of the present study, occurring in 6 of the 12 surveyed sites. This species has been previously classified as cryptogenic (ROCHA & KREMER 2005), however a recent genetic study showed that the individuals found along the Brazilian coast had invariable COI molecule, suggesting introduction of only one haplotype (ROCHA et al. 2012).

**Cirripedia**

Five of the six introduced species of barnacles reported for Brazil (CARLTON et al. 2011) occurred in Paraná and were found in this field survey, the only exception being *Amphibalanus subalbidus* (Henry, 1983). *Amphibalanus amphitrite* Darwin, 1854 and *Amphibalanus reticulatus* (Utinomi, 1967) are reported as the most common species in shipping records (CARLTON et al. 2011), and they have been reported as abundant on artificial substrata both inside PEC (CANGUSSU et al. 2010, KLÔH et al. 2013) and offshore (BUMBEER & ROCHA 2012). In this study, *A. amphitrite* occurred only in one site of artificial substrate, while *A. reticulatus* was registered on natural substrata inside PEC and in artificial reefs offshore. Both species have already been recorded in natural substrates, even though not abundant (KLÔH et al. 2013). In Paraná, *Balanus trigonus* Darwin, 1854 has been unfrequently recorded on artificial substrata
inside PEC (CANGUSSU et al. 2010), but frequently offshore (BUMBEER & ROCHA 2012). In the present survey the species was found only in the artificial reefs located offshore.

Megabalanus coccopoma Darwin, 1854 is not common in Paraná (CANGUSSU et al. 2010, BUMBEER & ROCHA 2012). Although it has been found only in three sites inside PEC in the subtidal region, it is reported to occur frequently in the intertidal region colonizing ropes, buoys and other artificial structures (J. Bumbeer, pers. comm.).

Striatobalanus amaryllis Darwin, 1854 has been previously reported in low frequencies in PEC (NEVES et al. 2007, CANGUSSU et al. 2010). However, this was the barnacle species that occurred in more sites in the present field survey, and it was the most abundant barnacle in artificial substrate offshore (BUMBEER & ROCHA 2012). Southern range expansion of this species requires special attention, since Paraná is the current southern limit of the reported geographical range.

Cnidaria

The three species of cnidarians found, the octocorals Stragulum bicolor van Ofwegen & Haddad, 2011 and Carijoa riisei (Duchassaing & Michelotti, 1860), and the hydrozoan Garveia franciscana Torrey, 1902, were classified as established. The first was found in seven different sites, mainly located inside PEC, except by Mel island, which is also under direct estuarine influence. Paranaguá Bay was the first place where the species has been recorded in the Brazilian coast, both on artificial and natural substrata around 15 years ago (VAN OFWEGEN & HADDAD 2011). However, S. bicolor has already been found away from the estuary, near Currais Archipelago (BUMBEER & ROCHA 2012) and on intertidal beach rocks at the neighbor state of Santa Catarina (VAN OFWEGEN & HADDAD 2011). The spread of the species to natural habitats, even inside estuarine environments, indicates its invasive behavior. Indeed, a recent study demonstrated that this species is efficient in occupying both pre-colonized and clean substrates (ALTIVATER & COUTINHO 2015).

Carijoa riisei has been introduced in the Atlantic long ago (CONCEPCION et al. 2010). In Paraná, the species have been recorded on artificial substrates inside Paranaguá Bay (M.D. Correia, pers. comm., CANGUSSU et al. 2010) and near Currais Islands (BUMBEER & ROCHA 2012). However, this survey showed that C. riisei was the most spread introduced species and frequent in natural habitats, mainly outside the PEC.

Garveia franciscana was first reported in Paranaguá Bay in 2004 (NEVES et al. 2007) and later it was found abundantly on experimental plates deployed offshore (BUMBEER & ROCHA 2012). Despite this last record, this species is typical of estuarine areas, and has not been found at open ocean sites since then. In this study it was recorded only inside PEC, and for the first time in natural substrate.

Decapoda

The crab Charybdis hellerii (A. Milne-Edwards, 1867) was first reported in Paraná in 2007, in areas of oyster aquaculture in both Paranaguá and Guaratuba bays (FRIGOTTO & SERAFIM-JUNIOR 2007). Later, one specimen was collected in trawling surveys during an Environmental Impact Study near Paranaguá Port (TCP 2010). Although not published, there are reports that this species is widespread inside Paranaguá Bay, occurring in intertidal areas at rocky shores. In the present study, C. hellerii was observed in one site (Bananas island). Probably more specimens and sites would be recorded if the field survey effort had been focused at intertidal zones.

Echinodermata

The ophiuroid Ophiotela mirabilis Verrill, 1867 was first reported from Brazil in 2000, in Rio de Janeiro (HENDLER et al. 2012). Since then, the species has been repeatedly collected from Bahia to Santa Catarina,
demonstrating its rapid spread. At Paraná, this species was observed at Mel island in 2009 (Hendler et al. 2012). Indeed, *O. mirabilis* was one of the most spread species of the present study, occurring in 6 of the 12 surveyed sites. Beyond Mel island, we collected the species in five new sites, located mainly offshore. The proliferation of *O. mirabilis* is enhanced by its capacity of fissiparous asexual reproduction, in addition to low host specificity, which may help it to colonize new habitats (Mantellato et al. 2016). We identified at least five different host species, including the gorgonian *Leptogorgia punicea* (Milne Edwards & Haime, 1857), the zoanthid *Parazoanthus swiftii* (Duchassaing & Michelotti, 1860) and the sponges *Mycale angulosa* (Duchassaing & Michelotti, 1864), *Tedania ignis* (Duchassaing & Michelotti, 1864) and *Polymastia janeirensis* (Boury-Esnault, 1973).

**Mollusca**

The invasive mytilid *Myoforceps aristatus* (Dillwyn, 1817) was first reported from Rio de Janeiro and São Paulo (Simone & Gonçalves 2006). Currently it is also known from Ceará, Bahia and Santa Catarina (Breves-Ramos et al. 2010, Agudo-Padrón 2011, Cavallari et al. 2012). In the present study, the species has been found boring oysters shells and barnacles in both natural and artificial substrata, in depths ranging between 3 and 18 m.

Other two exotic bivalves in Brazilian waters occur in Paraná, the mytilids *Perna perna* (Linnaeus, 1758) and *Isognomon bicolor* (Adams, 1845) (Lopes 2009, IAP 2015). Despite being a NIS, *P. perna* is considered a historically introduced species, which is widespread at both natural and artificial substrata, as well as largely cultivated in many states of Brazil, mainly those located in the southern region (Boscardin 2008).

**Polychaeta**

The species *Polydora cornuta* Bosc, 1802 has been first reported boring in shells of oysters attached to artificial substrata in 2004 inside PEC (Neves et al. 2007). It has not been retrieved in the present survey.

**Cryptogenic species**

In addition to the NIS just listed, the bryozoans *Amathia verticillata* (Delle Chiage, 1822) (formerly *Zoobotryon verticillatum*, see Wäschchenbach et al. 2015) and *Schizoporella errata* (Waters, 1878) were also found in our field sampling. The first one was found in our field surveys and is usually collected in large quantities during trawling activities in the PEC (F. Possato pers.comm.). The bryozoan *S. errata* was also found occupying vast areas of both natural and artificial substrates. This bryozoan has been included in the Brazilian list of marine invasive NIS (Lopes 2009), but is considered cryptogenic by some specialists, since we do not know its native geographical range (Vieira et al. 2008). There are also many discussions about the origin and invasibility potential of *A. verticillata*. The species has been labeled as cryptogenic in the Caribbean Sea and South Atlantic (Floerl et al. 2009), but recently Gallil & Gevili (2014) argue that its real native origin is the Caribbean Sea. Apart the controversy, its aggressive behavior when occupying substrates and widespread distribution suggest that this species require special attention regarding its abundance and possible impacts.

Another cryptogenic species in Paraná waters is the newly described hydrozoan *Podocoryna loyola* Haddad, Bettim & Miglietta, 2014 (Haddad et al. 2014). Molecular analysis and ecological characteristics – like colonization of artificial substrata in estuarine areas – suggests that *P. loyola* is more likely to be exotic to the region (Cangussu et al. 2010, Haddad et al. 2014). The species was not found in the present field survey, although it is a constant component of fouling community on experimental plates inside PEC. Thus, it is important to monitor its spread to natural habitats and possible impacts on native communities.
LITERATURE CITED


IAP (2015) Portaria nº 059, 15 de abril de 2015. Reconhece como espécies exóticas invasoras no estado do Paraná as espécies relacionadas nos Anexos 1 (Plantas), 2 (Vertebrados) e 3 (Invertebrados) da presente Portaria. Curitiba,
Instituto Ambiental do Paraná, available online at: http://www.iap.pr.gov.br/uploads/0a0fca82-a800-ee6d.pdf [Accessed: 14/07/2015]


