Pós-Graduação em Sistemas Costeiros e Oceânicos (PGSISCO)

Centro de Estudos de Mar (CEM)

Universidade Federal do Paraná (UFPR)

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HIDROCARBONETOS NO MATERIAL PARTICULADO DA BAÍA DE GUARATUBA, PR, E SISTEMAS AQUÁTICOS ADJACENTES.

Pontal do Paraná

Março de 2015

Ana Lúcia Lindroth Dauner

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Dissertação apresentada ao Programa de Pós-Graduação em Sistemas Costeiros e Oceânicos, Universidade Federal do Paraná, como requisito parcial para obtenção de grau de Mestre.

Orientador: Dr. César de Castro Martins

Pontal do Paraná

Março de 2015

... Não se prende nesse medo de errar,

Que é errando que se aprende.

O caminho até parece complicado

E às vezes tão difícil que você se surpreende

quando sente de repente que era tudo muito simples.

Vai em frente que você entende.

Gabriel, o Pensador

"Hidrocarbonetos no material particulado da Baía de Guaratuba, PR, Brasil, e sistemas aquáticos adjacentes"

por

Ana Lúcia Lindroth Dauner

Dissertação nº 124 aprovada como requisito parcial do grau de Mestre(a) no Curso de Pós-Graduação em Sistemas Costeiros e Oceânicos da Universidade Federal do Paraná, pela Comissão formada pelos professores:

Dr. César de Castro Martins (UFPR/CEM)
Orientador e Presidente
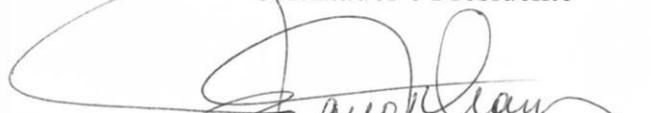
Dr. Marco Tadeu Grassi (UFPR)
Membro Examinador

Dr. Renato Rodrigues Neto (UFES)
Membro Examinador

Pontal do Paraná, 24/04/2015.

TERMO DE APROVAÇÃO

Ana Lucia Lindroth Dauner

Hidrocarbonetos no material particulado da Baía de Guaratuba, PR, Brasil, e sistemas aquáticos adjacentes

Dissertação aprovada como requisito parcial para a obtenção do grau de Mestre(a) em Sistemas Costeiros e Oceânicos, da Universidade Federal do Paraná, pela Comissão formada pelos professores:

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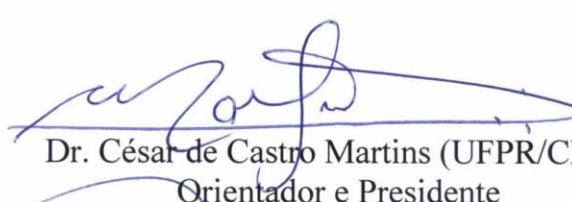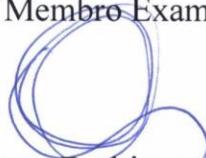Dr. Renato Rodrigues Neto (UFES)
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Pontal do Paraná,20/03/2015.

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RESUMO

O objetivo desta dissertação foi avaliar a distribuição espacial e temporal, de curta escala, de hidrocarbonetos (hidrocarbonetos policíclicos aromáticos – HPAs, hidrocarbonetos alifáticos – HAs, Alquilbenzenos lineares – LABs) no material particulado em suspensão (MPS) da Baía de Guaratuba, PR, Brasil, bem como identificar as suas principais fontes e verificar como os parâmetros da coluna d'água afetam a sua distribuição. Para tanto, foram coletadas 22 amostras em três períodos distintos (04/2013, 08/2013 e 03/2014).

De um modo geral, foram observados altos valores na porção mediana do estuário, relacionados a fenômenos hidrodinâmicos que contribuem para o acúmulo de matéria orgânica, gerando uma região atuante como um filtro geoquímico de partículas. Também foram observadas altas concentrações na desembocadura da baía, próximo à passagem de balsas indicando um aporte contínuo durante o ano, e na porção mais interna da baía, sugerindo o aporte fluvial como fonte da introdução de hidrocarbonetos. Por fim, foram observados altos valores de HPAs e de HAs próximo à marina de Guaratuba na coleta realizada durante o Carnaval (Março/2014), indicando um aumento da introdução desses compostos nesse período. Ainda, as maiores concentrações foram observadas durante o verão, período de aumento populacional na região.

A análise de razões diagnósticas permitiu avaliar as principais fontes dos hidrocarbonetos na Baía de Guaratuba. A distribuição dos HPAs e dos HAs sugere uma importante fonte petrogênica recente, provavelmente associada ao tráfego de embarcações e balsas na baía, além de uma contribuição natural de matéria orgânica proveniente de fontes biogênicas terrestres, provavelmente oriundas da floresta de manguezal existente nas margens da baía.

Assim, foi possível observar que a introdução de óleo e esgoto são problemas emergentes na Baía de Guaratuba, especialmente durante o verão. Além disso, este trabalho evidenciou a importância da avaliação de contaminantes em curtas escalas temporais e de considerar as características físico-químicas da coluna d'água em estudos de avaliação ambiental envolvendo o MPS, uma vez que eles podem ser responsáveis por acumular material orgânico em regiões afastadas de fontes pontuais de poluentes.

ABSTRACT

The aim of this work was to evaluate the spatial and temporal (short range) distribution of hydrocarbons (polycyclic aromatic hydrocarbons - PAHs, aliphatic hydrocarbons - AHs, Linear Alkyl Benzenes - LABs) in suspended particulate matter (SPM) in Guaratuba Bay, Brazil, as well as identify their main sources and observe how the parameters of the water column affect their distribution. For this purpose, 22 samples were collected in three distinct periods (04/2013, 08/2013 and 03/2014).

In general, we observed high values in the middle portion of the estuary, related to hydrodynamic phenomena that contribute to the accumulation of organic matter, creating a region that acts as a geochemical particulate filter. We also observed high concentrations in the bay mouth, next to the passage of ferries indicating a continuous supply throughout the year, and in the innermost portion of the bay, suggesting the fluvial contribution as a source of the hydrocarbon introduction. Finally, we observed high PAHs and HAs values near Guaratuba marina during Carnival (03/2014), indicating an increase in the introduction of these compounds in this period. Generally, the highest concentrations were observed during the summer, population growth period in the region.

The analysis of diagnostic reasons allowed us to evaluate the main sources of hydrocarbons in the Bay of Guaratuba. The distribution of PAHs and AHs suggests an important recent petrogenic source, probably associated with the traffic of vessels and ferries on the bay, as well as a natural contribution of organic matter from terrestrial biogenic sources, probably derived from the existing mangrove forest in the Bay shores.

Thus, it was observed that the introduction of oil and sewage are emerging problems in Guaratuba Bay, especially during the summer. In addition, this study showed the importance of the evaluation of contaminants in short timescales and to consider the physical and chemical characteristics of the water column in environmental assessment studies involving SPM samples, since they may be responsible for accumulating organic material areas far from the point sources of pollutants.

SUMÁRIO

PREFÁCIO

Estuários são caracterizados por receber grandes quantidades de matéria orgânica e nutrientes, provenientes da bacia de drenagem e da plataforma continental. Esse fluxo de material, aliado à transferência de energia e à reatividade interna do sistema (COSTA et al., 2010), faz com que esses ecossistemas sejam alguns dos mais importantes da biosfera em termos de atividade biológica (GATTUSO et al., 1998). No entanto, os estuários também estão sujeitos a diferentes tipos de mudanças ambientais originárias das atividades antrópicas existentes nas bacias de drenagem, nas margens e dentro do próprio estuário. Os principais impactos antrópicos em regiões estuarinas são as atividades portuárias e de navegação, drenagem urbana e descarte direto de efluentes urbanos e industriais (GRIGORIADOU et al., 2008; VENTURINI et al., 2008), as quais podem variar de intensidade ao longo do ano. Assim, devido à interação entre os ambientes marinho e terrestre, e à influência antrópica, os estuários são ecossistemas altamente variáveis, tanto na escala temporal quanto na escala espacial (BIANCHI, 2007).

O aporte de matéria orgânica e contaminantes em um ambiente pode ser determinado através do uso de marcadores orgânicos geoquímicos, os quais podem ser de origem natural ou antrópica, apresentam natureza específica e resistência à degradação (COLOMBO et al., 1989). Nesse grupo, incluem-se os hidrocarbonetos policíclicos aromáticos (HPAs), os hidrocarbonetos alifáticos (HAs) e os alquilbenzenos lineares (LABs).

Os HPAs são compostos orgânicos de origem petrogênica, pirolítica ou diagenética, associados principalmente a atividades antrópicas (WANG et al., 1999, 2009), podendo bioacumular e biomagnificar (VENTURINI et al., 2008; CHIZHOVA et al., 2013). Os HAs podem ser oriundos tanto de fontes naturais quanto petrogênicas (UNEP, 1992; BURNS & BRINKMAN, 2011; MARTINS et al., 2012a), sendo que a Mistura Complexa Não Resolvida (MCNR) é geralmente associada à presença de resíduos de óleo degradado (READMAN et al., 2002; MAIOLI et al., 2011). Por fim, os LABs são hidrocarbonetos presentes na matéria prima utilizada na composição dos principais surfactantes, sendo assim bons indicadores da introdução de esgotos

domésticos e industriais (RAYMUNDO & PRESTON, 1992; TAKADA & EGANHOUSE, 1998; MARTINS et al., 2012b).

Por se tratarem de moléculas de caráter apolar e, portanto, hidrofóbicas, os marcadores orgânicos geoquímicos tendem a se associar ao material particulado em suspensão (MPS) (MONTUORI & TRIASSI, 2012). O material particulado reflete as condições do sistema aquático no instante da coleta, sendo que a distribuição dos marcadores no ambiente está sujeita a alterações momentâneas tanto das fontes quanto de forçantes ambientais, como a salinidade e a concentração de MPS (LIU et al., 2014; RÜGNER et al., 2014). Assim, o MPS pode ser utilizado para avaliar a variabilidade espacial e temporal de contaminantes em ambientes com influência antrópica variável ao longo do ano. Assim, nos últimos anos, o comportamento dos hidrocarbonetos no material particulado de sistemas estuarinos e costeiros tem recebido cada vez mais atenção, uma vez que essas são áreas de transição onde os poluentes antrópicos podem ser transferidos para ecossistemas adjacentes, como as plataformas continentais (LUO et al., 2008; GUO et al., 2010; MAIOLI et al., 2011; MONTUORI & TRIASSI, 2012; LIU et al., 2014).

A Baía de Guaratuba, PR, Brasil, é um exemplo de um ambiente estuarino sob influência antrópica variável ao longo do ano. Ela apresenta uma área superficial de aproximadamente 50,2 km^2, e o aporte fluvial ocorre principalmente através dos rios São João e Cubatão na porção interna na baía (MARONE et al., 2006). Ela é margeada por florestas de manguezal e marismas e está inserida dentro da Área de Proteção Ambiental de Guaratuba, mas na sua desembocadura estão localizados os municípios de Guaratuba e Matinhos. A região não apresenta um grau elevado de industrialização, sendo que a agricultura e o turismo são as principais atividades econômicas (PIETZSCH et al., 2010). Durante o verão, ocorre um aumento de até seis vezes na população (IAP, 2006), o que acarreta na intensificação dos impactos antrópicos, como o tráfego de veículos e embarcações, e o despejo de efluentes. Dessa forma, diversos estudos já observaram a introdução de contaminantes na Baía de Guaratuba (SANDERS et al., 2006; PIETZSCH et al., 2010; FROEHNER et al., 2012; COMBI et al., 2013). No entanto, esses estudos focaram a análise da matriz sedimentar, a qual reflete a contaminação acumulada ao longo dos anos.

Assim, o objetivo deste estudo foi avaliar a distribuição espacial e temporal, de curta escala, dos hidrocarbonetos (HPAs, HAs e LABs) no MPS da Baía de Guaratuba, PR, Brasil, bem como identificar as suas principais fontes e verificar como os parâmetros da coluna d'água afetam a sua distribuição. Para tanto, foram coletadas 22 amostras de água superficial em três períodos distintos (Abril/2013, Agosto/2013 e Março/2014). Devido à importância ecológica e econômica da baía, estudos como este são essenciais para o estabelecimento de práticas adequadas e efetivas de manejo para a preservação dos recursos disponíveis.

Dessa forma, foram propostas as seguintes hipóteses: (i) se os contaminantes orgânicos forem oriundos da bacia de drenagem, então as concentrações de HPAs serão maiores na porção interna do estuário e durante períodos chuvosos; (ii) se o aumento populacional nas cidades que circundam a baía afetar as concentrações de HPAs, então os níveis de HPAs serão maiores durante o verão austral; (iii) se os HAs e os LABs possuem a mesma fonte, então as suas distribuições espaciais serão similares; (iv) se os hidrocarbonetos (HAs e LABs) forem relacionados a atividades antrópicas, então as suas concentrações variarão de acordo com a oscilação populacional.

Esta dissertação é formada por dois capítulos, sendo o primeiro deles referente à introdução de HPAs na Baía de Guaratuba, enquanto o segundo capítulo se foca na distribuição de HAs e LABs na Baía de Guaratuba. Ambos os capítulos estão formatados de acordo com as revistas pretendidas, indicadas abaixo dos cabeçalhos.

CAPÍTULO 1

Effect of seasonal population fluctuation in the temporal and spatial distribution of polycyclic aromatic hydrocarbons in a subtropical estuary.

1 **Effect of seasonal population fluctuation in the temporal and spatial distribution of**

2 **polycyclic aromatic hydrocarbons in a subtropical estuary.**

3

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18   **Research Highlights**

19

20   > PAH concentrations on surficial suspended particulate matter were determined.

21   > PAH temporal distribution appears to be affected by population fluctuations.

22   > The PAH spatial distribution and the water physical parameters were related.

23   > PAHs were primarily related to petrogenic sources, with some pyrolytic contribution.

24   > The distribution of alkyl PAHs with different molar weights was discussed.

Resumo

A Baía de Guaratuba é um estuário subtropical localizada dentro de uma Área de Proteção Ambiental e entre dois municípios turísticos. Apesar do recente crescimento de atividades antrópicas, a região ainda é considerada semiprístina. As cidades são fortemente influenciadas pelo turismo de veraneio. Hidrocarbonetos policíclicos aromáticos (HPAs) são poluentes orgânicos que podem ser introduzidos nos ambientes marinhos a partir de fontes petrogênicas ou pirolíticas. Com o intuito de avaliar a introdução recente de hidrocarbonetos do petróleo na Baía de Guaratuba, amostras de material particulado em suspensão (MPS) foram coletadas em 22 pontos e em três diferentes períodos (Abril/2013, Agosto/2013 e Março/2014). Os HPAs foram determinados através de cromatografia gasosa acoplada a um espectrômetro de massa (GC/MS). A área estudada foi setorizada em função dos parâmetros hidrológicos (temperatura, salinidade, oxigênio dissolvido e pH). As concentrações de HPAs totais variaram de 25,4 a 226,7 ng L^{-1}, sendo que os maiores valores foram observados durante o período de Carnaval (Março/2014) devido ao aumento populacional. Espacialmente, as maiores concentrações foram verificadas nas regiões mesohalina e euhalina do estuário, devido a características ambientais que favoreceram o acúmulo de material, e à proximidade a docas e marinas. As razões diagnósticas e a análise de componentes principais sugeriram fontes predominantemente petrogênicas, como o tráfego de embarcações na baía. As fontes pirolíticas, associadas a emissões veiculares, foram episódicas gerando uma menor contribuição.

Palavras-chave: Hidrocarbonetos aromáticos; Fontes petrogênicas; Material particulado em suspensão; Variações espaciais; Variações temporais; Baía de Guaratuba.

Abstract

Guaratuba Bay is a subtropical estuary in an Environmental Protection Area, located between two touristic cities, and despite the recent growth of anthropic activities, the region is considered semi-pristine. These cities are strongly influenced by seasonal increased population during austral summer. Polycyclic aromatic hydrocarbons (PAHs) are organic pollutants that can be introduced into marine environments from petrogenic or pyrolytic sources. To evaluate the recent introduction of petroleum hydrocarbons in Guaratuba Bay, samples of surficial suspended particulate matter (SPM) were collected at 22 sites and at three different times (April 2013, August 2013 and March 2014). PAHs were determined by gas chromatography coupled to a mass spectrometer (GC/MS). The studied area was sectored according to hydrological parameters (temperature, salinity, dissolved oxygen and pH). Total PAH concentrations ranged from 25.4 to 226.7 ng L^{-1}, and the highest concentrations were observed during the Carnival period (March 2014) due to the tourism and population increase. Spatially, the highest concentrations were verified in the mesohaline and euhaline estuarine regions and were related to the environmental characteristics that facilitate material accumulation and the proximity to ship docks, respectively. The diagnostic ratios and the principal component analysis suggest that the main sources of PAHs are petrogenic inputs related to the boat traffic in the bay. Pyrolytic sources presented a lower contribution because they are episodic and associated with vessel emissions.

Keywords: Aromatic hydrocarbons; Petrogenic Source; Suspended particulate matter; Spatial variations; Temporal variations; Guaratuba Bay.

Study area coordinates: 25°51.8'S; 48°38.2'W.

1. Introduction

Estuaries are characterized by receiving large amounts of organic matter, nutrients and detritus from the watershed and shallow continental shelf. This material flux, energy transference and environmental reactivity (Costa et al., 2010) make this ecosystem one of the most important in terms of biological activity (Gattuso et al., 1998). However, estuaries are also subject to different environmental changes caused by anthropogenic activities in the watersheds and estuarine margins, whose intensity may vary drastically throughout the year, especially in resort cities.

The organic matter input and contamination in coastal systems can be determined by organic geochemical proxies associated with anthropic sources due to their chemical stability and resistance to degradation (Colombo et al., 1989), thus aiding the comprehension of the *status* and transport of contaminants in a region. Polycyclic aromatic hydrocarbons (PAHs) can be bioaccumulated, and low molar weight (LMW, two to three rings) PAHs present chronic toxicity, whereas certain PAHs with a high molar weight (HMW) are carcinogenic (Chizhova et al., 2013; Readman et al., 2002). Due to these characteristics, the United States Environmental Protection Agency (EPA) has included 16 PAHs on their priority pollutant list (Wang et al., 2008).

Because of their hydrophobicity, PAHs tend to associate with suspended particulate matter (SPM) (Montuori and Triassi, 2012), which can reflect the aquatic system conditions at the time of the sampling campaign. The environmental distribution of PAHs is subject to alterations of the sources and environmental conditions, such as salinity and SPM concentration (Liu et al., 2014). Thus, in recent years, the trend of PAHs on SPM from estuarine and coastal systems has received increasing attention, as pollutants can be transferred from these transition areas into adjacent ecosystems, such

99   as continental shelves (Liu et al., 2014; Maioli et al., 2011; Montuori and Triassi, 2012;

100   Yang et al., 2013).

101   Therefore, the aim of this study was to determine the concentrations and spatial

102   distribution of PAHs on the SPM from a subtropical estuary located in the southwestern

103   Atlantic Ocean (Guaratuba Bay) during three periods with distinct water column

104   characteristics and anthropogenic influences, and to identify the primary sources of the

105   PAHs, including the spatial and temporal variability due to population oscillation and

106   different environmental conditions. The following hypotheses were proposed: (i) if

107   there are organic contaminants coming from the watershed, then the PAH

108   concentrations will be higher in the internal portion of the estuary and during rainy

109   periods; and (ii) if the increased population in the cities surrounding the bay affects

110   PAH concentrations, then the levels will be higher during the austral summer holiday.

111

112   **2. Study area**

113   Guaratuba Bay is located on the southern coast of Paraná State, Brazil,

114   (25°51.8'S; 48°38.2'W) and has a surficial area of approximately 50.2 km^2 and a mean

115   depth of 3 m (Fig. 1). The estuary has a fairway that reaches 27 m in its mouth, whereas

116   24% of the estuary is formed by tidal flats (Marone et al., 2006). The watershed covers

117   an area of approximately 1,724 km^2, and the freshwater runoff, with a mean flow of

118   more than 80 m^3 s^{-1} (Marone et al., 2006), is formed by two main rivers, the Cubatão

119   and São João Rivers, which flow into the inner portion of the estuary (Mizerkowski et

120   al., 2012). The area surrounding the bay is primarily formed by mangrove forests and

121   salt marshes, and the region is in an Environmental Protection Area (APA Guaratuba)

122   (Pietzsch et al., 2010).

123   The region is not industrialized, and the main economic activity is agriculture

124   (Pietzsch et al., 2010), followed by fishery, mollusc collection from natural banks and

125   aquaculture (Lehmkuhl et al., 2010). The cities of Guaratuba and Matinhos are located

126   on the southern and northern margins, respectively, with approximately 61,000

127   inhabitants (IBGE, 2010) in both of the municipalities. However, during the austral

128   summer, this number reaches nearly 400,000 inhabitants, including permanent residents

129   and tourists (IAP, 2006). In addition, during the middle austral summer period,

130   Carnival, the biggest celebration in Brazil, occurs and lasts for five days during which a

131   significant number of people visit the beaches. Vehicle transport by ferries occurs

132   approximately every 30 minutes in the narrowest portion of the estuary mouth, and

133   during the austral summer vacation period, more than 500,000 vehicles are transported

134   by five ferries (Alves, 2014).

135   Despite the environmental relevance, few studies have been developed to

136   evaluate the organic contamination in Guaratuba Bay. The presence of estrogens in

137   recent sediments (Froehner et al., 2012), detectable levels of polychlorinated biphenyls

138   (PCBs) and organochlorine pesticides (Combi et al., 2013), increasing levels of mercury

139   (Hg) (Sanders et al., 2006) and PAHs (Pietzsch et al., 2010) primarily after the 1960s

140   have indicated the effects of human occupation on the region.

141

142   **3. Material and Methods**

143   *3.1. Sampling*

144   Three campaigns of surficial water sampling were conducted at 22 sites in

145   Guaratuba Bay and its surrounding area (Fig. 1, Table 1). The sites were chosen to

146   cover geographically the bay with 1 km semiregular intervals among the samples. The

147   samples were obtained during ebb spring tides, and the rainfall conditions are shown in

148   Fig. 2. The precipitation was monitored for nine days before the sampling because the

149   residence time of Guaratuba Bay is approximately 9.3 days (Marone et al., 2006). The

150   precipitation data were obtained from two pluviometric stations, one at the Guaratuba

151   dock and the other on the Cubatão River. The former reflects the rainfall conditions in

152   the bay, whereas the latter reflects the precipitation in the watershed, thus reflecting the

153   conditions of the material input into the bay.

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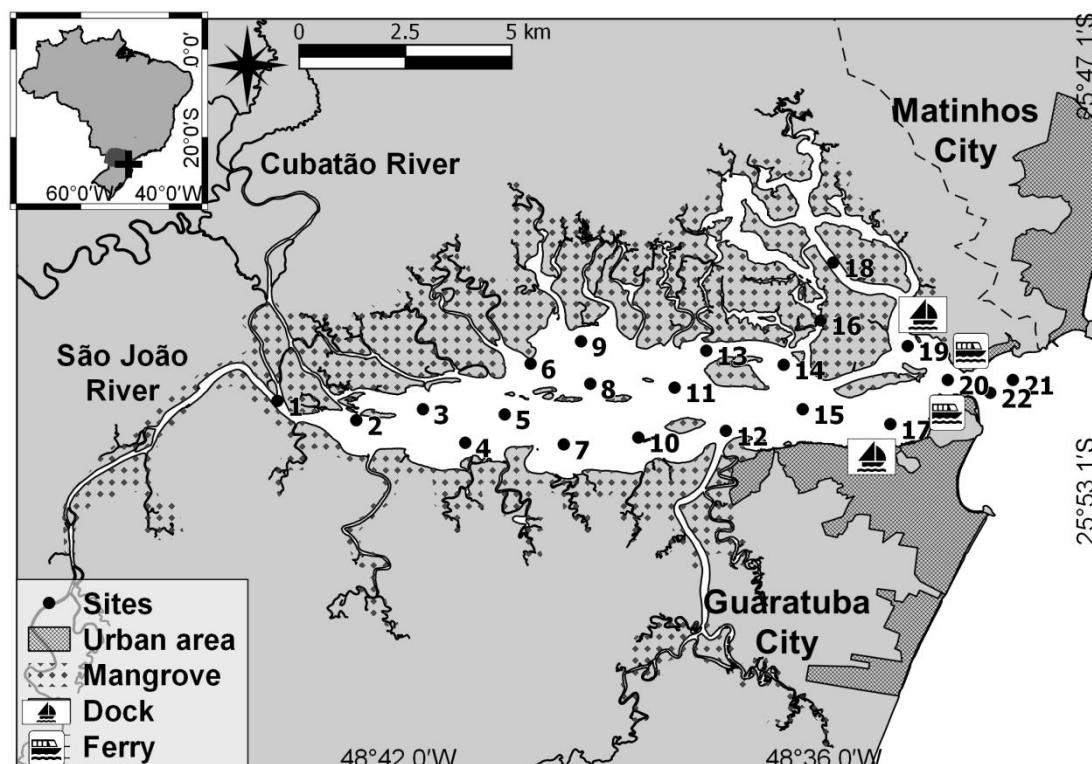
155
156   Fig. 1. Study area map indicating the sample sites location.
157

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158 Table 1. Sites coordinates, mean water depth (in meters), mean data and standard deviation of the
159 temperature (in °C), salinity (in PSU), pH, dissolved oxygen (DO; in % saturation) and total polycyclic
160 aromatic hydrocarbons (PAHs) (in ng L^{-1}) in the samples from Guaratuba Bay, SW Atlantic.

Site	Latitude	Longitude	Mean depth [m]	Temperature [°C]	Salinity [UPS]	pH	DO [% sat]	PAHs [ng L^{-1}]
1	25° 51' 50" S	48° 43' 43" W	2.9	22.6 ± 2.9	5.1 ± 3.0	7.0 ± 0.3	82.1 ± 7.0	93.2 ± 51.0
2	25° 52' 06" S	48° 42' 36" W	2.2	23.0 ± 3.0	6.2 ± 2.9	7.4 ± 0.1	84.4 ± 6.5	68.5 ± 42.4
3	25° 51' 57" S	48° 41' 39" W	2.2	23.1 ± 3.0	8.7 ± 4.5	7.5 ± 0.5	89.9 ± 11.3	67.5 ± 44.0
4	25° 52' 25" S	48° 41' 04" W	4.6	23.4 ± 3.3	10.8 ± 4.4	7.2 ± 0.3	95.3 ± 11.7	28.7 ± 9.7
5	25° 52' 01" S	48° 40' 30" W	2.8	23.7 ± 3.4	13.5 ± 3.6	7.5 ± 0.4	95.4 ± 11.0	187.5 ± 219.6
6	25° 51' 18" S	48° 40' 08" W	1.4	23.8 ± 3.2	13.4 ± 2.9	7.3 ± 0.3	91.9 ± 0.8 [a]	59.6 ± 14.8
7	25° 52' 27" S	48° 39' 40" W	1.4	23.7 ± 3.4	17.0 ± 1.7	7.5 ± 0.2	90.4 ± 10.2	148.8 ± 161.0
8	25° 51' 35" S	48° 39' 18" W	2.1	23.6 ± 3.3	14.5 ± 2.9	7.5 ± 0.3	91.4 ± 12.0	195.6 ± 56.3
9	25° 50' 59" S	48° 39' 26" W	2.0	22.3 ± 3.4	18.4 ± 0.6	7.4 ± 0.2	92.3 ± 5.4	203.2 ± 163.1 [b]
10	25° 52' 21" S	48° 38' 37" W	1.2	23.7 ± 3.6	20.7 ± 1.9	7.5 ± 0.2	92.2 ± 10.4	167.8 ± 53.6
11	25° 51' 39" S	48° 38' 06" W	3.1	23.8 ± 3.5	20.7 ± 1.1	7.6 ± 0.2	90.3 ± 9.1	75.5 ± 32.6
12	25° 52' 15" S	48° 37' 23" W	6.5	23.5 ± 3.6	22.4 ± 3.7	7.6 ± 0.2	91.7 ± 8.5	25.4 ± 3.1
13	25° 51' 07" S	48° 37' 40" W	1.6	23.7 ± 3.3	18.1 ± 0.9	7.2 ± 0.1	75.7 ± 4.0	47.8 ± 9.0
14	25° 51' 19" S	48° 36' 34" W	0.8	23.7 ± 3.6	22.6 ± 0.6	7.8 ± 0.1	91.5 ± 4.9	62.6 ± 25.4
15	25° 51' 57" S	48° 36' 18" W	7.4	23.4 ± 3.7	25.2 ± 4.8	7.7 ± 0.2	92.1 ± 7.6	226.7 ± 299.8
16	25° 50' 42" S	48° 36' 03" W	1.8	23.8 ± 3.3	22.3 ± 0.4	7.5 ± 0.1	79.1 ± 7.7	48.2 ± 37.9
17	25° 52' 10" S	48° 35' 04" W	6.2	23.5 ± 3.9	29.0 ± 2.0	7.9 ± 0.0	90.5 ± 5.3 [c]	138.8 ± 125.2
18	25° 49' 53" S	48° 35' 52" W	4.7	23.9 ± 3.3	22.0 ± 0.8	7.5 ± 0.3	76.8 ± 9.4	59.6 ± 34.8 [d]
19	25° 51' 03" S	48° 34' 49" W	2.1	23.7 ± 3.7	24.6 ± 1.8	7.6 ± 0.2	86.3 ± 8.4	94.1 ± 68.0
20	25° 51' 32" S	48° 34' 15" W	9.0	23.4 ± 4.0	30.8 ± 1.2	7.8 ± 0.2	93.9 ± 4.4	63.9 ± 29.7
21	25° 51' 32" S	48° 33' 20" W	12.3	23.5 ± 4.0	31.3 ± 0.7	7.9 ± 0.1	96.7 ± 2.1	81.4 ± 60.7
22	25° 51' 43" S	48° 33' 39" W	3.4	23.4 ± 4.0	31.5 ± 0.9	7.8 ± 0.2	97.0 ± 2.5	178.4 ± 75.6

161 [a] mean values from two sampling campaigns (April 2013 and August 2013)
162 [b] mean values from two sampling campaigns (April 2013 and August 2013; site #9 was not collected in
163 March 2014)
164 [c] mean values from two sampling campaigns (April 2013 and March 2014)
165 [d] mean values from two sampling campaigns (April 2013 and August 2013; site #18 from the March 2014
166 campaign did not present acceptable values of recoveries and was excluded from the analysis)
167
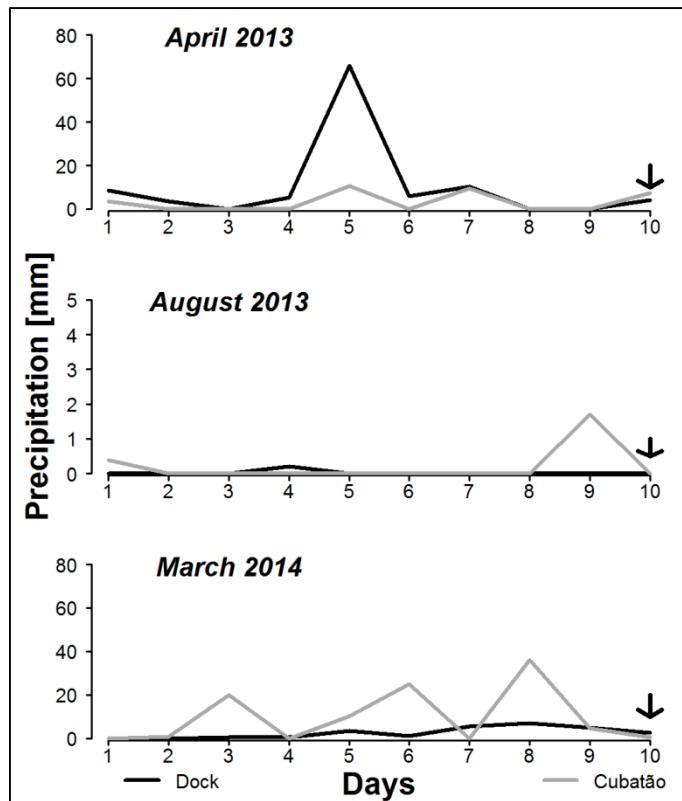
Fig. 2. Precipitation (in millimeters) in Guaratuba Bay during the nine days before the samplings (arrows indicate the sampling day).

The sampling grid was defined to properly understand the evolution of the biogeochemical processes along the salinity gradient. The sampling sites geographically cover the bay with semi-regular intervals of 1 km. Certain sampling sites were also selected in the fluvial channels to evaluate the direct input from the watershed.

Samples of the surficial water were collected for SPM determination using previously washed and decontaminated 4L amber glasses. Water samples were also collected for the dissolved oxygen (DO) and pH determination. The temperature, salinity and depth were obtained *in situ* with CTD profiles (CastAway P/N 400313 SonTek).

3.2. Analytical procedure

3.2.1. Hydrological parameters

The DO analysis followed the titration method described by Winkler (1888),

using an automatic titrator (Metrohm 702 SM Titrino), and the pH values were obtained

using a pHmeter (Denver UP-25).

From the total sampled volume, 3.5 L were filtered. The SPM was retained on

GF/F Whatman® (⌀ 0.45 μm) filters, previously calcinated at 450°C for 12 h, cooled in

a desiccator and weighed individually. The filters with the SPM were frozen and freeze-

dried for the seston determination and organic compound analyses. The SPM was

determined using a gravimetric method.

3.2.2. PAHs

The PAH analysis followed the method described for a sedimentary matrix and

was adapted from Wisnieski et al. (2014). The filters with the SPM were Soxhlet

extracted with 90 mL of ethanol (EtOH):dichloromethane (DCM) (2:1, v/v), and a

mixture of deuterated PAHs was added as surrogate standards (SS). The resultant

extracts were concentrated using rotary evaporation.

The extracts were then purified and fractionated by liquid chromatography on

5% deactivated silica and alumina columns. The extracts were eluted with hexanes to

remove the saturated hydrocarbons, and a mixture of hexanes and dichloromethane

(3:7,v/v) was used to elute the PAHs. The PAH fraction was concentrated using a rotary

evaporator and a slight stream of nitrogen, and was spiked with the internal standard

benzo(b)fluoranthene-d$_{12}$.

The PAHs were analyzed using an Agilent GC 7890A gas chromatograph

equipped with an Agilent 19091J-433 capillary fused-silica column coated with 5%

207   diphenyl/dimethylsiloxane (30 m length, 0.25 mm ID, 0.25 mm film thickness) and

208   coupled with an Agilent 5975C inert MSD with a Triple-Axis Detector Mass

209   Spectrometer, following an adaptation of the method described by Martins et al. (2012).

210   Helium was used as the carrier gas. The temperature of the GC oven was programmed

211   as follows: from 40°C to 60°C at 20°C min^{-1}, then to 250°C at 5°C min^{-1} and, finally, to

212   300°C at 6°C min^{-1} (held for 20 min). The injector temperature was adjusted to 280°C.

213   Splitless mode was adopted. The detector and ion source temperatures were adjusted to

214   300°C and 230°C, respectively.

215   The data were acquired using SIM (Selected Ion Monitoring) mode, and the

216   quantification was based on each compound's peak area integration using an Agilent

217   Enhanced Chemstation G1701 CA. The PAHs were identified by matching the

218   retention time and ion mass fragments with the results obtained from the standard

219   mixtures (AccuStandard Z-014G-FL PAHs Mix), with a calibration curve ranging

220   from 0.1 to 2.0 ng μL^{-1}. The complete list of PAHs analyzed is presented as

221   Supplementary data.

222

223   *3.2.3. Analytical control*

224   The analytical control was based on extraction blanks and the recoveries of the

225   SS in all of the samples. Procedural blanks were performed for each series of 11

226   samples, and the results of the blanks were sufficiently low (< 3 times the detection

227   limit) to not interfere with the analyses of the target compounds. The mean of the

228   analyte values in the blanks was discounted from the samples.

229   The deuterated PAH surrogate recoveries were considered satisfactory, with

230   mean values of 45 ± 14% for phenanthrene-d_{10}, 56 ± 19% for chrysene-d_{12} and 53 ±

231   19% for perylene-d_{12} for at least 80% of the samples analyzed. Although reference

23

232   material for the SPM was unavailable, regular analyses of the reference material for

233   sediment from the IAEA (International Atomic Energy Agency, IAEA-408) showed

234   satisfactory results, with recoveries for most of the target PAHs ranging from 90 to

235   110%. The detection limits (DL) were 1.4 ng L^{-1} for PAHs, based the lowest sensitive

236   PAH concentration (0.02 ng μL^{-1}), multiplied by the final extracted volume (250 μL)

237   and divided by the filtered water volume (3.5 L).

238

239   *3.3. Data analysis*

240   The data were treated using the QuantumGIS version 2.4.0 software (Nanni et

241   al., 2014), to create maps with the spatial distribution of the PAHs.

242   Statistical analyses and graphs were performed using the software R 3.0.3.

243   Based on hydrological parameters (temperature, salinity, DO and pH), a cluster

244   analysis, based on the Euclidean distance, was performed to verify the existence of

245   groups subject to the same changes in the water parameters in each of the sampling

246   campaigns. To determine a mean trend, a cluster analysis was performed based on the

247   integration of the campaigns. A multivariate approach was also adopted, using a

248   principal component analysis (PCA) to verify the similarity among the different PAHs

249   (descriptors), and to determine their influence on the sample distribution in each

250   campaign. From the spreadsheet containing all of the PAHs (with concentrations above

251   the DL and normalized by the percentage of the total PAHs), a score analysis was

252   performed to determine the compounds that explained more than 25% of the data on the

253   principal components (PC) 1 and 2. Based on this selection, new PCA were built

254   including only the PAHs with the highest explanation percentage (Table SD1).

255

4. Results and Discussion

4.1. Hydrological parameters

Pietzsch et al. (2010) suggested that the estuarine circulation and salinity may also have an important role as environmental conditions in the transport/deposition of the sedimentary PAH. Therefore, the temperature, salinity, pH and DO data were used to build clusters for each sampling campaign. In each campaign, Guaratuba Bay could be categorized into three sectors according to the hydrological influences (fluvial, marine and mixture zone; similarity limit of 10%), and the sampling sites grouped into the sectors varied according to the campaigns. The samples were considered marine-influenced due to the highest values of salinity, DO and pH, whereas the fluvial-influenced samples presented the lowest values of those parameters due to the proximity to rivers.

In April 2013 (Fig. 3), the oligohaline region encompassed the sampling sites near the São João and Cubatão river mouths (Fluvial 1 sector) and the sites in or near the rivers of the north margin (Fluvial 2 sector). Fluvial 1 sector presented lower values of SPM, whereas Fluvial 2 sector presented relatively higher concentrations (Fig. 4), which suggested the input of terrestrial material. The euhaline region was restricted to the influence of the estuary mouth and to the beginning of the main ebb channel (Marine sector). The mesohaline region was divided into two sectors: one sector under the influence of the São João and Cubatão Rivers (Mixture Zone 1 sector) and the other sector in the middle of the bay (Mixture Zone 2 sector). The highest SPM values and the shallower depths were presented in Mixture Zone 2, especially on the north margin. Therefore, the seston input may be related to the terrestrial input via river flows or sediment resuspension.
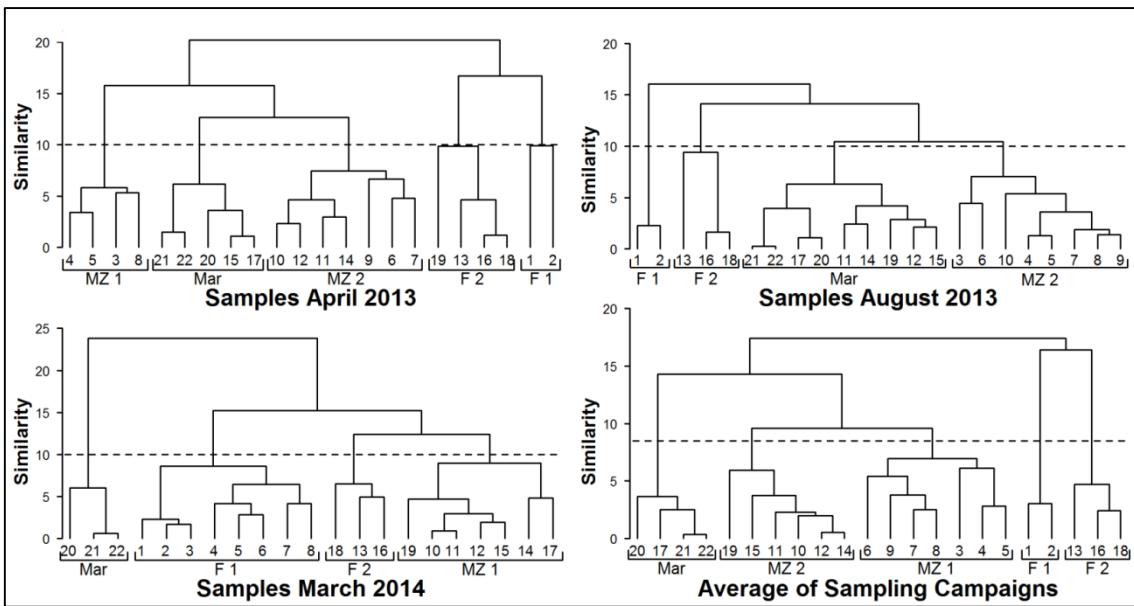
281
282 Fig. 3. Cluster analysis (involving the temperature, salinity, DO, pH and SPM concentration parameters)
283 of the water samples from Guaratuba Bay for each sampling campaign and for the campaign average. Mar
284 = Marine, MZ 1 = Mixture Zone 1, MZ 2 = Mixture Zone 2, F 1 = Fluvial 1, F 2 = Fluvial 2.
285
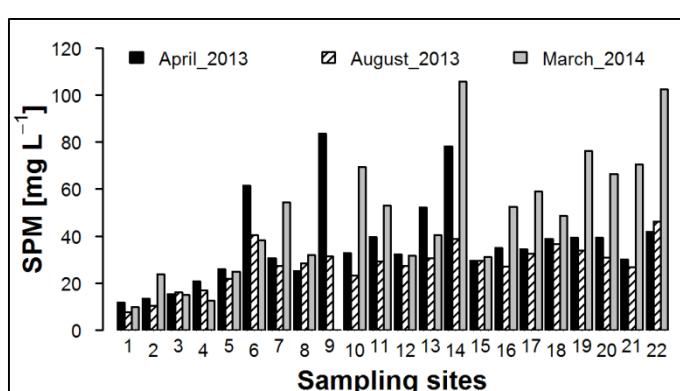
286
287 Fig. 4. Suspended particulate material (in mg L^{-1}) in water samples from Guaratuba Bay, during the
288 sampling campaigns in April 2013, August 2013 and March 2014. Sampling site #9 was not collected in
289 March 2014.
290

291   In August 2013 (Fig. 3) and in April 2013, the oligohaline region encompassed

292 the sampling sites near the river mouths (Fluvial 1 and 2 sectors). However, because of

293 the lowest rainfall, the euhaline region (Marine sector) advanced into the estuary,

294 reaching the middle of the bay. Because of the intrusion of more saline waters into the

295 estuary, sampling sites #3 to #10 represented the inner position of the estuarine Mixture

296 Zone. The SPM concentrations were lower compared with the other campaigns and the

297 highest values were observed in the Marine sector (Fig. 4), suggesting a minor

26

298 contribution of terrestrial material from the watersheds, which could be caused by the

299 relatively low precipitation rates in this period (Fig. 2).

300   In March 2014 (Fig. 3), the effect of the highest pluviometric values registered

301 on the Cubatão basin was observed. Fluvial 1 sector encompassed the bay upstream,

302 whereas Fluvial 2 sector encompassed only three sites, and the Marine sector was

303 restricted to the estuary mouth. Thus, the Mixture Zone was located in an outer position

304 compared with August 2013. Generally, the highest values of SPM were observed in the

305 mesohaline and euhaline regions. Based on a visual analysis of the filters, the

306 predominant material of the SPM of the external samples consisted of coarser fractions

307 than those found in the intermediate sites, as verified by Mizerkowski et al. (2012).

308 Because the SPM concentrations are based on the mass of the material retained on the

309 filters, and because of the probable difference between the crystalline matrix densities,

310 the values observed in the outer samples suggest a denser SPM compared with other

311 sampling sites.

312   Finally, the cluster of the average variation of the hydrological parameters in

313 Guaratuba Bay (Fig. 3, Table 1) emphasizes the estuary sectoring (cut into 8%). The

314 Marine sector was restricted to the estuary mouth and to the beginning of the main ebb

315 channel. The Fluvial sectors encompassed the sites near the São João and Cubatão

316 Rivers and the rivers of the north margin. Generally, the highest SPM concentrations

317 were observed in the mesohaline region, most likely due to the increased bay width and,

318 consequently, in the tidal prism. This increase leads to a decrease in the flow velocities

319 (fluvial and marine) creating an area of material accumulation (Marone et al., 2006). In

320 addition, there is a significant lateral input of detritus and dissolved substances from the

321 mangrove forests existing on the north margin (Mizerkowski et al., 2012).

322

323   *4.2. Spatial and temporal distribution of PAHs*

324   The PAH concentration can be expressed in terms of the filtered water volume

325   (e.g., Chizhova et al., 2013; Liu et al., 2014) as the SPM mass retained on the filters

326   (e.g., Curtosi et al., 2009; Maioli et al., 2011). Generally, the samples presented a

327   similar trend, regardless of the concentration unit (Fig. SD1).

328   The spatial distributions of the total PAHs (in ng L^{-1}) on the SPM from

329   Guaratuba Bay for the three samplings campaigns are shown in Fig. 5. In April 2013,

330   the concentrations ranged from 21.02 to 366.28 ng L^{-1}, and the highest values were

331   observed in the estuarine mixture zone (sampling sites #8, #9 and #10; Fig. 3). The

332   relatively high concentrations were found in a region that acts as a particle trap due to

333   the increased bay width and the merging of opposite flows. Additionally, those sites,

334   which are primarily the north margin, are located far from urbanized areas and are

335   therefore far from potential sources of petroleum hydrocarbons as urban runoffs. The

336   upstream region and the estuary mouth presented moderate PAH concentrations. The

337   PAHs detected in the inner part of Guaratuba Bay (sector Fluvial 1) may be related to

338   the vehicle traffic on an existing road that follows the São João River for more than 15

339   km, while the main source of PAHs on the estuary mouth (sector Marine) may be

340   related to the ferry traffic, the urban runoff of Guaratuba City and the presence of a

341   semi-commercial fishing fleet.

342
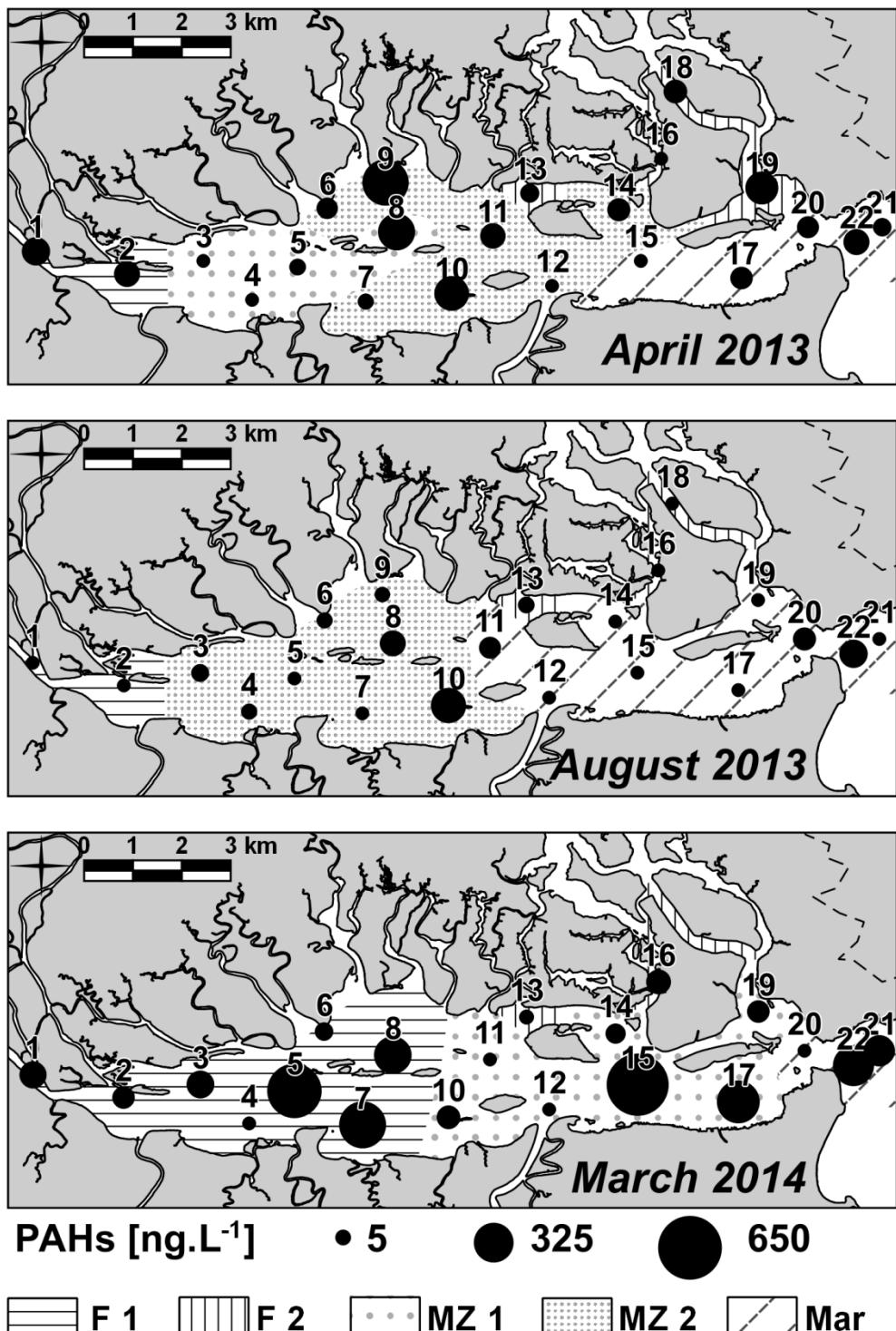
Fig. 5. Spatial distribution of the total PAHs (in ng L^{-1}) on surficial suspended particulate matter from Guaratuba Bay, SW Atlantic. The values in the circled scale represent the lowest, intermediate and highest concentrations of PAHs. Mar = Marine, MZ 1 = Mixture Zone 1, MZ 2 = Mixture Zone 2, F 1 = Fluvial 1, F 2 = Fluvial 2.

In August 2013, during the austral winter, the samples presented the lowest PAH

concentrations, ranged from 5.89 to 208.87 ng L^{-1} (Fig. 5), which could be explained by

351 the reduced tourism and the consequent reduction of urban runoff and vessel traffic. The

352 highest values were observed at sites #8 and #10 (sector Mixture Zone 2), such as in

353 April 2013, which were related to the maximum turbidity zone existing in the estuarine

354 mixture zone. High concentrations were also found at sites #20 and #22 (sector Marine)

355 and were most likely associated with the ferries and vessel activities, which emphasize

356 the importance of these PAH sources throughout the year.

357   In March 2014, the highest concentrations of total PAHs were observed, ranging

358 from 20.39 to 650.51 ng L^{-1} (Fig. 5), with relatively high values at sites #5, #7, #15 and

359 #17. The importance of the middle region as a geochemical particle filter was again

360 observed due to the high values at sites #5 and #7. Sites #15 and #17 may be affected by

361 a local source, the Guaratuba dock. This sampling campaign was performed during the

362 Carnival period when there is an intense touristic activity in the region, resulting in an

363 increase in urban runoff and in the number of moving vessels. Rice et al. (2008) also

364 observed that the PAH concentrations increased sharply during summer periods, due the

365 use intensification of recreational watercraft in a small Alaskan lake.

366   Based on the three campaigns, the mean concentrations of the total PAHs ranged

367 from 25.40 to 226.69 ng L^{-1} (Fig. 6, Table 1). The spatial distribution evidenced three

368 regions with high PAH concentrations. One region encompassed sites #5, #7, #8, #9 and

369 #10 in the estuarine mixture zone (sector Mixture Zone 1). These findings show the

370 importance of physico-chemical processes in the retention of fine particles in this

371 region, thus favoring the adsorption of organic contaminants on the SPM.

372
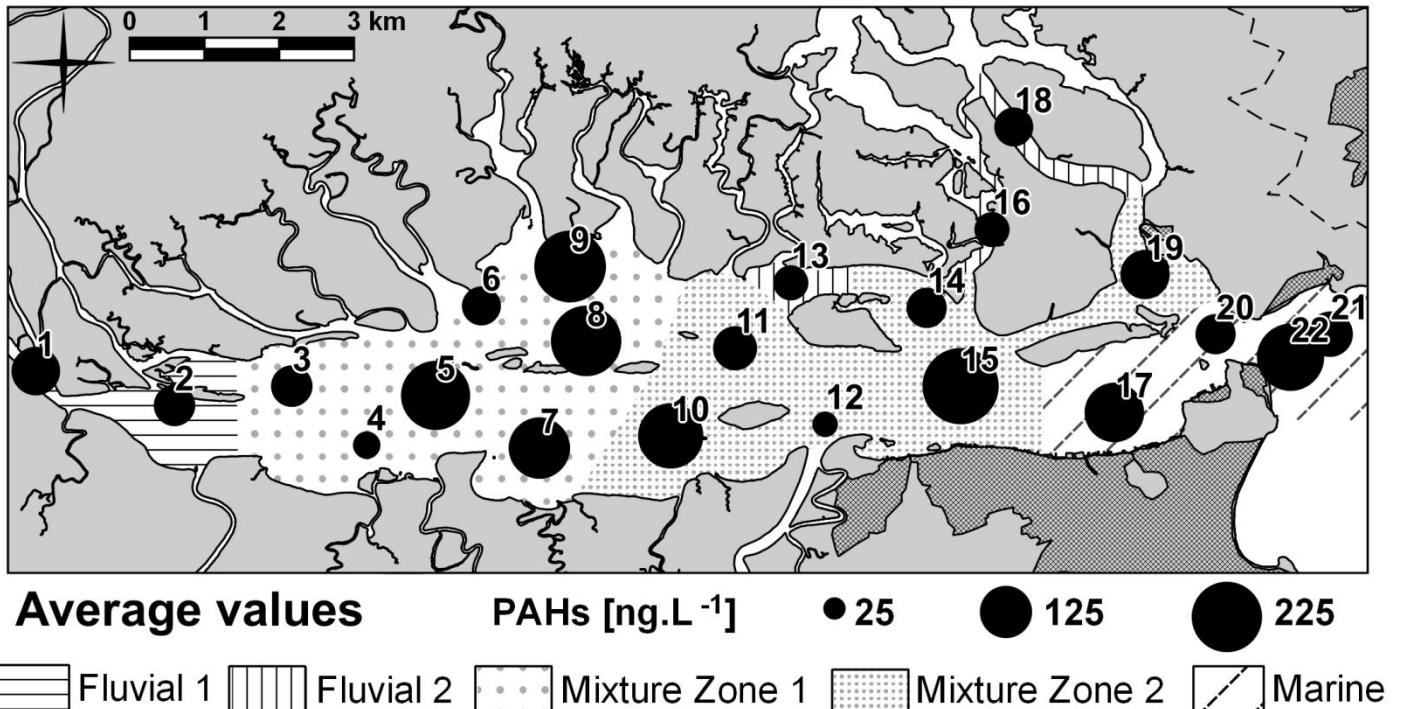
Fig. 6. Spatial distribution of the total PAH averages (in ng L^{-1}) on surficial suspended particulate matter from Guaratuba Bay, SW Atlantic. The values in the legend represent the lowest, intermediate and highest concentrations of PAHs.

The second region encompasses the estuarine outer portion (sites #21 and #22 – sector Marine) and the PAHs may be related to the local sources of petroleum hydrocarbons, such as vessels, ferries and fishing boats. This region also acts as a second particle filter. Primarily during ebb tides, the tidal currents lose the capacity to transport in the estuary mouth due to the increase in the section area, resulting in the deposition of the material from the estuary and hindering its transport to the shelf (Angulo, 1999). Finally, the third region (sites #15 and #17) presented high mean concentrations of total PAHs due to the high values observed in March 2014, during the Carnival holiday. The values were related to local sources because of the drastically increase in tourism and moving vessels during the Carnival period, especially near the docks.

390   *4.3. Comparison with other studies*

391   The PAH concentrations in the SPM observed in Guaratuba Bay were below

392   those observed in highly urbanized and industrialized regions (Fig. 7) of Italy (Montuori

393   and Triassi, 2012) and several estuaries and rivers of China (Guo et al., 2007; Liu et al.,

394   2014). Because of it wide range, the highest values observed in Guaratuba Bay are of

395   the same magnitude as other anthropized environments, such as the French and Spanish

396   coast of the Mediterranean Sea (Guitart et al., 2007), the Maguaba Lagoon and the

397   Paraíba do Sul River in Brazil (Maioli et al., 2011), and the Langat River in Malaysia

398   (Bakhtiari et al., 2009), whereas the other values are comparable with pristine regions,

399   such as Antarctica (Chizhova et al., 2013; Curtosi et al., 2009). Therefore, the PAH

400   concentrations verified in Guaratuba Bay indicate that this region, although considered

401   semi-pristine in previous studies (Cotovicz Junior et al., 2013; Pietzsch et al., 2010), is

402   already showing evidence of anthropic impacts.
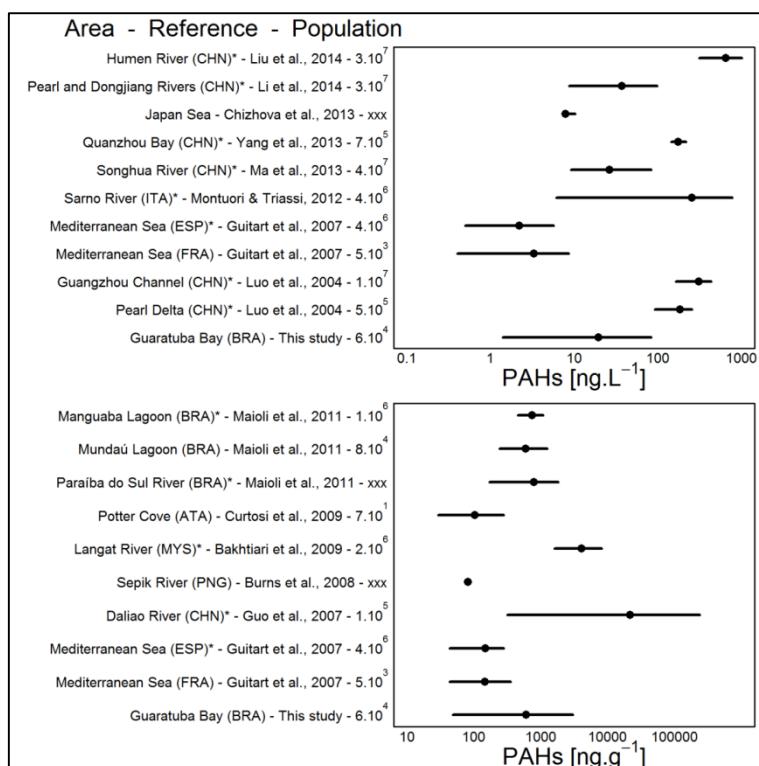
403
404   Fig. 7. Concentration range of the Σ16PAHs on suspended particulate matter from different coastal
405   regions of the world and the estimated population. * industrialized area; xxx = no data available.
406

4.4. Evaluation of PAH sources by diagnostic ratios

407

408   Diagnostic ratios can be calculated from certain HMW PAH isomer

409   concentrations to determine the primary PAH sources in an environment (Yunker et al.,

410   2002). However, because the concentrations of most HMW compounds were below the

411   DL, only the ratio between phenanthrene and methyl phenanthrene could be calculated

412   (Fig. 8). According to this ratio, SPM samples collected in Guaratuba Bay were

413   influenced primarily by petrogenic sources, especially fuel spills during refueling of

414   boats and leakage during navigation (Pietzsch et al., 2010). The average values obtained

415   were 0.29 ± 0.09 in April 2013, 0.33 ± 0.11 in August 2013 and 0.27 ± 0.13 in March

416   2014. Only a few samples, especially those collected in August 2013, suggested that the

417   PAHs were from pyrolytic sources, primarily those associated with the combustion of

418   oil and its derivatives. However, this trend was not consistent with the other sampling

419   campaigns, strengthening the petrogenic contribution as the main component of the

420   PAH input in this environment.

421
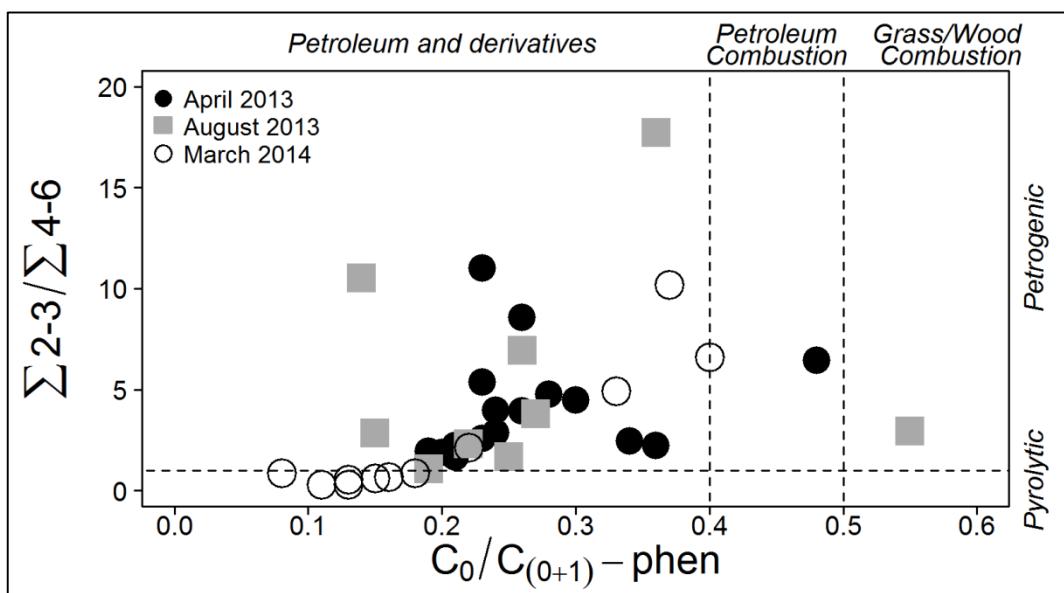
422
423   Fig. 8. Cross plot of the diagnostic ratios $\Sigma(2\text{-}3)/\Sigma(4\text{-}6)$ versus C_0-phenanthrenes/$\Sigma(C_0+C_1)$phenanthrenes
424   (when they could be calculated) on the samples of the surficial suspended particulate matter from
425   Guaratuba Bay, SW Atlantic.

426

427   The $\Sigma(2\text{-}3)/\Sigma(4\text{-}6)$ ratio is also used to determine the primary sources of PAHs.

428   The relative predominance of LMW PAHs is more related to petrogenic input, whereas

429   HMW PAHs are associated with combustion processes (Wang et al., 1999). In 78% of

430   the calculated ratios, the predominance of LMW PAHs was observed ($\Sigma(2\text{-}3)/\Sigma(4\text{-}6) >$

431   1.0) (Fig. 8). Values below 1.0 were observed only in March 2014, suggesting the

432   punctual and sporadic introduction of PAHs by pyrolytic sources. Therefore, this ratio

433   confirms the introduction of crude oil and its derivatives as the main source of

434   petroleum hydrocarbons into Guaratuba Bay, and a mixture of sources can occur

435   occasionally.

436   Finally, all of the samples presented a predominance of alkylated compounds,

437   ranging from 59% to 92% of the total PAHs. Wang et al. (1999) observed that samples

438   subjected to a recent introduction of petroleum showed large quantities of alkylated

439   compounds, corroborating the recent introduction of petroleum and its derivatives as the

440   main source of PAHs in Guaratuba Bay.

441   Perylene is one of the few PAHs that can be associated with natural and

442   anthropogenic sources (Montuori and Triassi, 2012; Venkatesan, 1988). Perylene was

443   the only pentacyclic PAH found, suggesting a diagenetic origin from natural, most

444   likely terrigenous, precursors (Readman et al., 2002). Most of the samples containing

445   perylene were collected in the sampling sites near the north margin (64%), which could

446   receive a considerable input of organic matter from the mangrove forest.

447

448   *4.5. Principal Component Analysis*

449   The PCA was performed with the most abundant PAHs, namely naphthalene,

450   C_1-naphthalene, C_2-naphthalene, phenanthrene, C_1-phenanthrene and C_2-phenanthrene

451   (Fig. 9). Principal component (PC) 1 explained more than 80% of the data and was

34

452   related to the C_2-phenanthrenes and naphthalenes, whereas PC 2 explained 12% of the

453   variability and was associated with phenanthrene and also naphthalenes. Generally,

454   marine-influenced sites presented a higher proportion of C_2-phenanthrenes, the same

455   observed by Leonov and Nemirovskaya (2011), whereas sites #3, #10 and #20

456   presented a higher proportion of naphthalenes. The samples from the mixture zone did

457   not present a clear distribution pattern for the individual PAHs, but they appeared to be

458   more associated with the phenanthrenes.

459
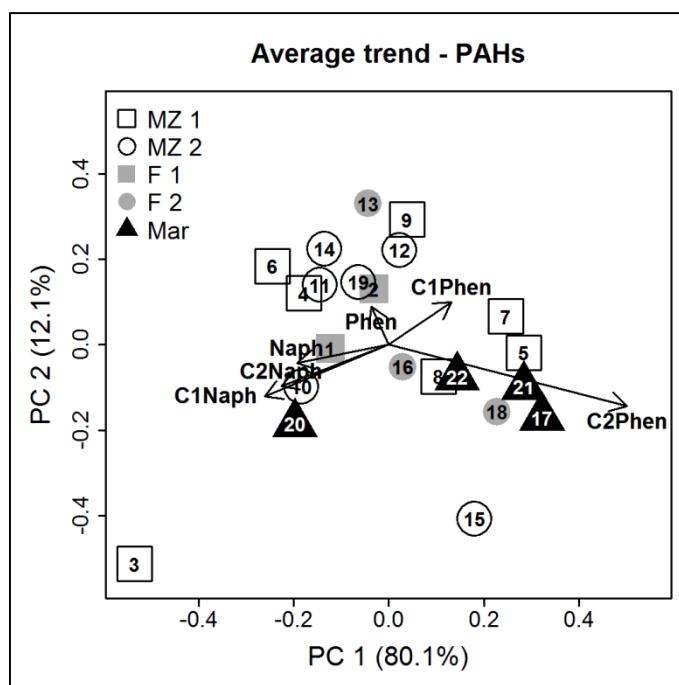
461 Fig. 9. Principal Component Analysis based on PAH average concentrations in samples of surficial
462 suspended particulate matter from Guaratuba Bay, SW Atlantic. Mar = Marine, MZ 1 = Mixture Zone 1,
463 MZ 2 = Mixture Zone 2, F 1 = Fluvial 1, F 2 = Fluvial 2.

464

465   Sites that are influenced by naphthalenes and those influenced by phenanthrenes

466   can be distinguished by their volatilization, solubilization, degradation and sorption

467   processes (Huang et al., 2004; Lee et al., 1978; Massie et al., 1985). Naphthalenes are

468   more volatile and more soluble than phenanthrenes. Furthermore, naphthalene

469   degradation has been reported in waters from pristine and oil-contaminated ecosystems

470   (Herbes and Schwall, 1978; Lee and Ryan, 1983; Lee et al., 1978; Massie et al., 1985).

471　Naphthalene is relatively water soluble (31.2 mg L^{-1}) and has a high vapor pressure

472　(0.08 mm Hg at 20-25°C), indicating that biodegradation and volatilization in open

473　waters may be important processes that affect its fate in aquatic systems. The addition

474　of a third fused-benzene ring (phenanthrene) significantly decreases the compound's

475　water solubility (30 to 700 times lower), vapor pressure (330 to 1,180 times lower) and

476　microbial degradation rates (2 to 50 times lower) (Bauer and Capone, 1985; Herbes and

477　Schwall, 1978; Herbes, 1981; Huang et al., 2004; Lee et al., 1978; Rochman et al.,

478　2013), what causes it to be the most stable polyarene in the geochemical background

479　(Leonov and Nemirovskaya, 2011). This suggest the sites mainly influenced more by

480　naphthalenes may be exposed to a fresher material input than those sites more related to

481　phenanthrenes, especially site #20 that is located in the ferries trajectory.

482　　　　The different rates of adsorption among the alkylated PAHs may also explain

483　this separation between the compounds. Oren et al. (2006) have suggested that regions

484　with high levels of aromatic compounds and vegetal lipids promote adsorption and

485　scavenging of phenanthrene on SPM compared with other PAHs. Because the PAH

486　polarity tends to diminish as the molar weight increases (Delgado-Saborit et al., 2013)

487　and adsorption on the SPM depends on the polarity (Rochman et al., 2013),

488　alkylphenanthrenes should present a higher adsorption rate than the parental compound.

489　Thus, the greater tendency of alkylphenanthrene adsorption on SPM can explain this

490　differentiation in samples with high PAH concentrations (#5, #7, #8, #9, #15 and #22),

491　as suggested by Pietzsch et al. (2010). This sorption distinction could also explain the

492　elevated association between site #3 and naphthalenes,

493　　　　Another possible explanation for this distinction could be the existence of

494　different sources of these alkyl PAHs. Although the predominant source of PAHs in

495　Guaratuba Bay is petrogenic, certain PAHs can be related to pyrolytic introductions.

496 Alkylnaphthalenes are strong indicators of the presence of crude oil and its derivatives

497 (Kim et al., 2006), whereas alkylphenanthrenes (especially dimethylphenanthrenes)

498 have been shown to originate from pyrolytic processes, such as vehicle emissions

499 (Aboul-Kassim and Simoneit, 1995; Pereira et al., 1999; Yunker et al., 2002). The

500 samples sites from the Marine sector (#17, #21 and #22) and the sites near the docks

501 (#15, #17 and #18) presented a higher proportion of alkyl PAHs with higher molar

502 weights. Thus these regions can be subject to the introduction of PAHs from

503 combustion of fuels in vessels.

504

505 **5. Summary and Conclusions**

506   The spatiotemporal variations of PAH concentrations adsorbed on SPM in a SW

507 Atlantic subtropical estuary was studied. The results showed that the spatial distribution

508 of the PAHs varies according to the population oscillation and meteorological factors.

509 Based on physico-chemical parameters, it was possible to separate the bay into three

510 different areas with relatively constant patterns throughout the year. Generally, the

511 middle and outer regions of the estuary presented the highest PAH concentrations. The

512 former region is located far from anthropic activities and the physico-chemical

513 parameters were useful to explain this distribution, once the presence of the estuarine

514 mixture zone favors the material retention and pollutant accumulation. The marine-

515 influenced region is located near the docks and ferries, which, in addition to urban

516 runoff, are the primary sources of hydrocarbons in the bay. This spatial distribution

517 refutes the hypothesis (i) that fluvial inputs are significant PAH sources to this

518 environment. The temporal distribution, with the highest PAH concentrations near

519 Guaratuba dock, did not refute the hypothesis (ii), emphasizing the importance of the

37

520   sharp population increase during summer holidays, which intensifies the hydrocarbon

521   input in Guaratuba Bay.

522   The PAH concentrations in Guaratuba Bay are in the same range as those

523   observed in certain pristine environments and certain impacted regions, indicating that

524   although considered semi-pristine, this estuary is already subject to anthropic effects.

525   The analysis of the diagnostic ratios and the PCA showed that the main source of

526   petroleum hydrocarbons to the bay is crude oil and its derivatives, and a mixture of

527   sources related with the sporadic introduction of pyrolytic PAH from the vessel traffic

528   may occur. Because the diffuse input of crude oil and its derivatives from vessels is the

529   main entry route of PAHs in Guaratuba Bay, public programs to monitor and inspect the

530   vessels, especially during high seasons when occurs a seasonal and sharp population

531   increase, would assist in the mitigation of the chronic anthropic effect.

532

544

545 **Appendix A. Supplementary data**

546   Supplementary data to this article can be found online at

547 http://dx.doi.org/XX.XXX.

548

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Appendix A. Supplementary data

725

726 Table SD1. Explanation percentage of the polycyclic aromatic hydrocarbons of the two first principal
727 components of the Principal Component Analysis. Naph = naphthalene; Acy = acenaphthylene; Flu =
728 fluorene; Phen = phenanthrene; Ant = anthracene; BaA = benz[a]anthracene; Chry = chrysene; IndP =
729 indeno[1,2,3-cd]pyrene; C1naph = methylnaphthalene; C2naph = dimethylnaphthalene; C3naph =
730 trimethylnaphthalene; C1phen = methylphenanthrene; C2dbt = dimethyldibenzothiophene; C2phen =
731 dimethylphenanthrene; C1fla = methylfluoranthene; C1pyr = methylpyrene; C1chry = methylchrysene;
732 Ret = retene; Peryl = perylene.

	PC1	PC2
Naph *	0.01	0.48 *
Acy	0.00	0.03
Flu	0.00	0.01
Phen *	0.05	0.11 *
Ant	0.00	0.00
BaA	0.00	0.00
Chr	0.02	-0.01
IndP	0.00	0.01
C1naph *	0.01	0.48 *
C2naph *	0.04	0.57 *
C3naph	0.00	0.07
C1phen *	0.40 *	0.22 *
C2dbt	0.02	-0.01
C2phen *	0.88 *	-0.19 *
C1fla	0.11	-0.06
C1pyr	0.09	-0.05
C1chr	0.01	-0.01
Ret	0.03	-0.02
Peryl	0.00	0.04
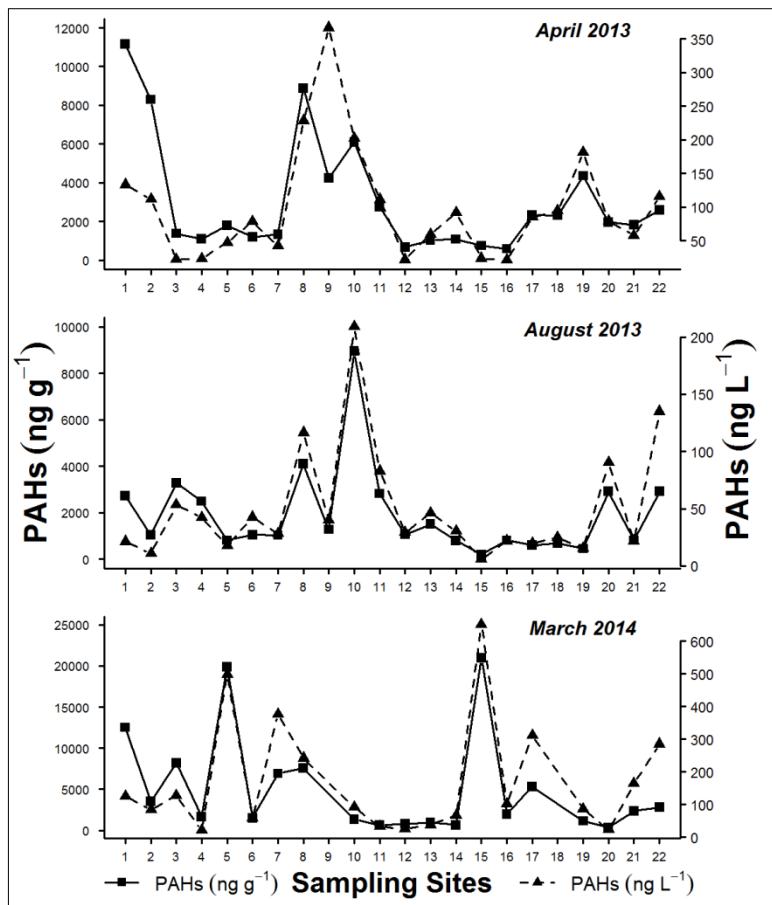
733
734   Fig. SD1. PAH concentrations (in ng g^{-1} SPM and in ng L^{-1}) of filtered water samples from Guaratuba
735   Bay, SW Atlantic, from each sampling campaign.

CAPÍTULO 2

Spatial and temporal distribution of aliphatic hydrocarbons and linear alkylbenzenes in the particulate phase from a subtropical estuary (Guaratuba Bay, SW Atlantic) under seasonal population fluctuation.

1 **Spatial and temporal distribution of aliphatic hydrocarbons and linear**

2 **alkylbenzenes in the particulate phase from a subtropical estuary (Guaratuba Bay,**

3 **SW Atlantic) under seasonal population fluctuation.**

4

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16   **Research Highlights**

17

18   > AH and LAB contents were determined on surficial suspended particulate matter.

19   > Temporal and spatial distributions and compositions of AHs and LABs were

20   evaluated.

21   > AHs were related to petrogenic and biogenic sources.

22   > LABs showed preferential degradation during the austral summer.

Resumo

A Baía de Guaratuba, um estuário subtropical localizado no Atlântico SO, está sob a influência de uma pressão antrópica variável ao longo do ano. Amostras de material particulado em suspensão foram coletadas em 22 pontos durante três diferentes períodos a fim de avaliar a variabilidade espacial e temporal dos hidrocarbonetos alifáticos (HAs) e alquilbenzenos lineares (LABs). Esses compostos foram determinados através de cromatografia gasosa acoplada a um detector por ionização de chama (GC-FID) e a um espectrômetro de massa (GC/MS). As distribuições espaciais de ambos os compostos foram similares e variaram entre as campanhas amostrais. De modo geral, as maiores concentrações foram observadas durante o verão, realçando a importância do aumento de intensidade da pressão antrópica durante esse período. As distribuições dos compostos também foram afetadas por processos geoquímicos naturais de acúmulo de matéria orgânica. Os HAs foram associados à introdução de petróleo e derivados, a partir do tráfego de embarcações e veículos, e a fontes biogênicas, como as florestas de manguezal e a produção autóctone. A composição de LABs evidenciou a sua degradação preferencial durante o verão.

Palavras-chave: fontes; degradação; material particulado em suspensão; variações espaciais; variações temporais.

23 **Abstract**

24 Guaratuba Bay, a subtropical estuary located in the SW Atlantic, is under variable

25 anthropic pressure throughout the year. Samples of surficial suspended particulate

26 matter (SPM) were collected at 22 sites during three different periods to evaluate the

27 temporal and spatial variability of aliphatic hydrocarbons (AHs) and linear

28 alkylbenzenes (LABs). These compounds were determined by gas chromatography with

29 flame ionization detection (GC-FID) and mass spectrometry (GC/MS). The spatial

30 distributions of both compound classes were similar and varied among the sampling

31 campaigns. Generally, the highest concentrations were observed during the austral

32 summer, highlighting the importance of the increased human influence during this

33 season. The compound distributions were also affected by the natural geochemical

34 processes of organic matter accumulation. AHs were associated with petroleum, derived

35 from boat and vehicle traffic, and biogenic sources, related to mangrove forests and

36 autochthonous production. The LAB composition evidenced preferential degradation

37 processes during the austral summer.

38

39 **Keywords:** sources; degradation; suspended particulate matter; spatial variations;

40 temporal variations.

41 **Study area coordinates:** 25°51.8'S; 48°38.2'W.

1. Introduction

Coastal environments are influenced by anthropic activities throughout the year

and may receive organic and inorganic contaminant loads through riverine, terrestrial

and autochthonous emissions. Some of the primary sources of organic pollutants to

estuarine regions are shipping and harbor activities, urban runoff and the direct

discharge of industrial and urban wastes (Grigoriadou et al., 2008; Venturini et al.,

2008). This anthropic influence can also be intensified during specific periods that are

generally associated with temperature and hydrological cycle changes (Jennerjahn,

2012). Due to the interaction between terrestrial and marine environments, estuaries are

highly variable environments on both temporal and spatial scales (Bianchi, 2007).

Several studies using molecular proxies have determined the contamination in

several coastal areas of the world (e.g. Martins et al., 2014; Montuori and Triassi, 2012;

Notar et al., 2001; Pinturier-Geiss et al., 2002), but the majority of these studies have

used a sedimentary matrix, which causes difficulty when evaluating on a short time

scale.

Only a few studies have focused on the temporal variability based on the

evaluation of contaminants in the water column and suspended particulate matter

(SPM). Because most organic markers are lipophilic and have a high octanol-water

partition coefficient (Ni et al., 2009; Wang et al., 2008), SPM can be a useful tool to

evaluate the temporal and spatial variability in regions in which the anthropic influence

may vary significantly over the year.

The transport of hydrophobic organic pollutants, such as hydrocarbons, in rivers

and estuaries is primarily coupled to the transport of suspended particles (Schwientek et

al., 2013). Therefore, the total concentrations of hydrophobic pollutants tend to increase

with increasing discharge, e.g., during floods, which increases the SPM input, possibly

86   remobilizing the bottom sediments (Rügner et al., 2014). Due to the characteristics of

87   organic proxies, such as persistency and source specificity (Colombo et al., 1989;

88   Kannan et al., 2012), it is possible to determine the source (anthropogenic, terrestrial or

89   marine) of the compounds and their degradation degree (e.g., Aboul-Kassim and

90   Simoneit, 1996; Luo et al., 2008). Linear alkylbenzenes (LABs) are known as sewage

91   tracers (e.g., Martins et al., 2012a; Raymundo and Preston, 1992; Takada and

92   Eganhouse, 1998), whereas aliphatic hydrocarbons (AHs) are associated with natural

93   and anthropic sources (Burns and Brinkman, 2011; Colombo et al., 1989; Martins et al.,

94   2012b).

95   Guaratuba Bay, located in the SW Atlantic, is an example of a region with a

96   variable temporal anthropic pressure. The number of inhabitant increases drastically

97   during the summer season (IAP, 2006). Several studies have been developed to evaluate

98   the organic contamination in Guaratuba Bay and have indicated increased levels of

99   mercury and polycyclic aromatic hydrocarbons (Pietzsch et al., 2010; Sanders et al.,

100   2006) as well as detectable levels of estrogens and polychlorinated biphenyls (Combi et

101   al., 2013; Froehner et al., 2012). However, these studies have focused on the analysis of

102   the sedimentary matrix, which presents an accumulated contamination on a relatively

103   long-time scale.

104   Because estuaries are areas of ecological and economic value, understanding the

105   contaminant transport and the fate in estuaries is imperative for adopting effective

106   management initiatives to protect these resources. Therefore, the objective of this study

107   was to evaluate the spatial and temporal variability in the distribution and composition

108   of AHs and LABs in the surface SPM for the determination of the priority regions and

109   periods to implement management policies. Therefore two hypotheses have been

110   proposed: (i) if AHs and LABs have the same sources, then their spatial distribution will

111   be similar; (ii) if the organic markers are related to anthropic activities, then their

112   concentrations will vary according to population fluctuation.

113

114   **2. Study area**

115   Guaratuba Bay is located on the southern coast of Paraná State, Brazil, SW

116   Atlantic (25°51.8'S; 48°38.2'W) (Fig. 1). The bay has a surface area of approximately

117   50.2 km^2, and the depth can reach 27 m, while 42% is formed by tidal flats. The primary

118   freshwater inflow into the bay is through the Cubatão and São João Rivers (Marone et

119   al., 2006; Mizerkowski et al., 2012). The area surrounding the bay is primarily formed

120   by mangrove forests and salt marshes, and the region is in an Environmental Protection

121   Area (APA Guaratuba) (Pietzsch et al., 2010).

122
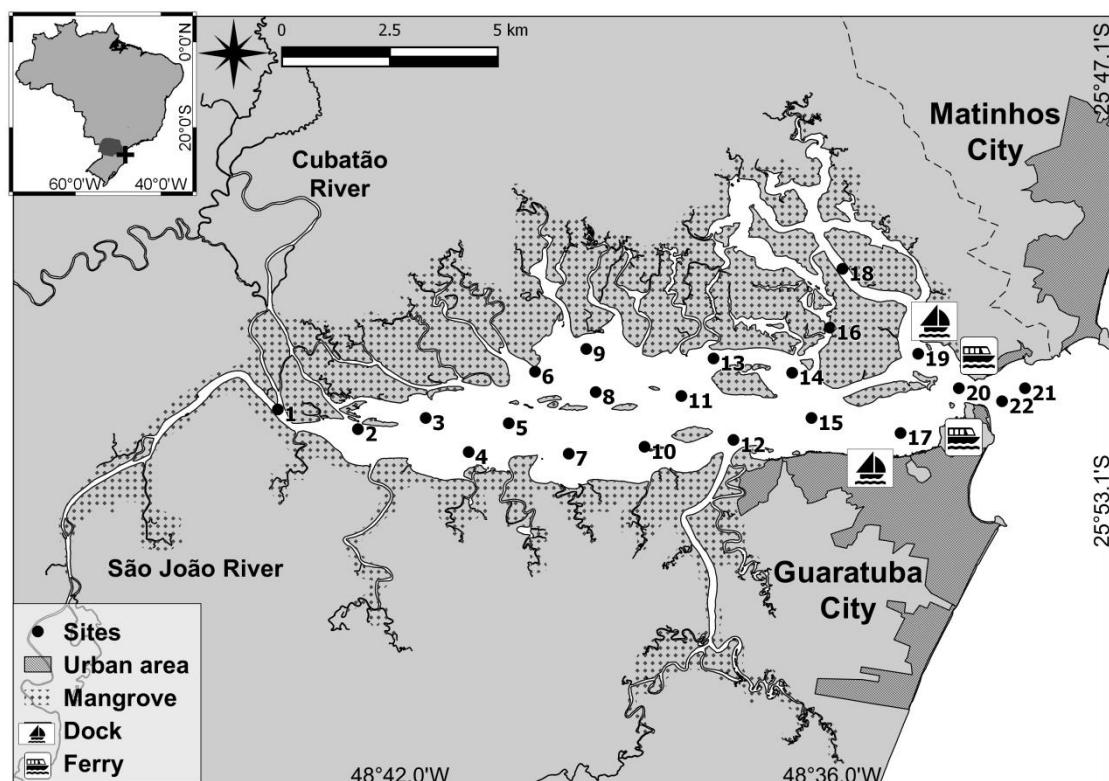
123
124   Fig. 1. Study area and sampling sites in Guaratuba Bay, SW Atlantic.
125

126   The primary economic activities throughout the year are agriculture and fishery

127   (Lehmkuhl et al., 2010; Pietzsch et al., 2010). During the austral summer, tourism

128   enhances the economic activities in the cities of Guaratuba and Matinhos, located on the

129   southern and northern margins, respectively. The number of inhabitant can increase six-

130   fold, reaching nearly 400,000 inhabitants, including permanent residents and tourists

131   (IAP, 2006; IBGE, 2010). In the narrowest portion of the estuary mouth, a vehicle

132   transport by ferries occurs approximately every 30 minutes.

133

134   **3. Material and Methods**

135   *3.1. Sampling*

136   Sampling was performed in three campaigns (April 2013, August 2013 and

137   March 2014) during ebb spring tides, at 22 sites in Guaratuba Bay and its surrounding

138   area (Fig. 1). The campaign dates were selected to encompass three distinct

139   environmental and anthropic conditions. April 2013 and March 2014 represent the

140   austral summer, with warm and wet weather conditions, while August 2013 represents

141   the austral cold, dry winter. The difference between the summer campaigns is the level

142   of human impact. The March 2014 sampling occurred during the Brazilian Carnival,

143   when a significant number of people visit the coastal zone. The April 2013 sampling did

144   not occur on any holiday, therefore representing the most typical anthropic effect

145   throughout the year.

146   Surface water was collected using previously washed and decontaminated 4 L

147   amber glasses. Temperature, salinity and depth were obtained *in situ* with CTD profiles

148   (CastAway P/N 400313 SonTek).

149

150   *3.2. Analytical procedure*

151   *3.2.1. Sample preparation*

152   Surface water samples (approximately 3.5 L) were vacuum filtered through GF/F

153   Whatman® (⌀ 0.45 μm) filters, previously calcinated at 450 °C for 12 h, to obtain the

154   SPM. The filters with SPM were freeze-dried and stored until analysis. SPM was

155   determined using a gravimetric method.

156

157   *3.2.2. Sample extraction and instrumental analysis*

158   The analytical procedure for hydrocarbons analysis was based on the United

159   Nations Environment Programme (UNEP, 1992) and was adapted from Wisnieski et al.

160   (2014) as described for a sedimentary matrix. The filters with the SPM were Soxhlet

161   extracted with 90 mL of ethanol (EtOH):dichloromethane (DCM) (2:1, v/v) for 8 h and

162   spiked with the surrogate standards 1-eicosene and 1-C_{12}-LAB (purchased from Supelco

163   Analytical) for the quantitation of AHs and LABs, respectively. The resultant extracts

164   were concentrated using rotary evaporation.

165   The extracts were purified and fractionated by liquid chromatography on 5%

166   deactivated silica and alumina columns. The extracts were eluted with hexanes to

167   remove the saturated hydrocarbons, and 10 mL of hexanes was used to elute the AHs

168   and LABs. The fraction was concentrated using a rotary evaporator with a slight stream

169   of nitrogen and was spiked with the internal standard 1-tetradecene (Supelco

170   Analytical).

171   The instrumental analysis procedures used to quantify the AHs and LABs are

172   described in Dauner et al. (2015). AHs were analyzed using an Agilent GC (model

173   7890A) equipped with a flame ionization detector and an Agilent 19091J-413 capillary

174   fused silica column coated with 5% diphenyl/dimethylsiloxane (30 m in length, 0.32

175   mm ID, and 0.25 μm film thickness). Hydrogen was used as the carrier gas. The oven

176   temperature was programmed to ramp from 40 °C to 60 °C at 20 °C min^{-1}, then to 290

177   °C at 5 °C min^{-1} and, finally, to 300 °C at 5 °C min^{-1}, remaining constant for 9 min.

178   The compounds were individually identified by matching their retention times with

179   those from standard mixtures of *n*-alkanes (C$_{10}$–C$_{40}$), pristane and phytane

180   (AccuStandard DRH-008S-R2), over the range from 0.25 to 15.0 μg L^{-1}.

181   The LABs were analyzed using an Agilent GC 7890A gas chromatograph

182   equipped with an Agilent 19091J-433 capillary fused-silica column coated with 5%

183   diphenyl/dimethylsiloxane (30 m length, 0.25 mm ID, 0.25 mm film thickness) coupled

184   with an Agilent 5975C inert MSD with a Triple-Axis Detector Mass Spectrometer,

185   following an adaptation of the method described by Martins et al. (2010). Helium was

186   used as the carrier gas. The temperature of the GC oven was programmed as follows:

187   from 40 °C to 60 °C at 20 °C min^{-1}, then to 290 °C at 5 °C min^{-1} and, finally, to 300 °C

188   at 5 °C min^{-1}. The injector temperature was adjusted to 280 °C. The splitless mode was

189   adopted. The detector and ion source temperatures were adjusted to 300 °C and 230 °C,

190   respectively.

191   The data were acquired using the SIM (Selected Ion Monitoring) mode, and the

192   quantification was based on each compound's peak area integration using an Agilent

193   Enhanced Chemstation G1701 CA. Calibration was performed based on an external

194   standard solution containing 1-Cm LABs (m = 10, 11, 13 and 14) (Supelco Analytical,

195   99% purity) at different concentrations (0.1 to 2.0 ng μL^{-1}). LABs were identified by

196   ion mass fragments (m/z 91, 92 and 105) and by matching the retention times with a

197   mixture of all of the n-Cm-LABs (m = 10-13) provided by Deten Química S.A. (LABs

198   Mix Lot LPS 0025/08).

199

3.2.3. Analytical control

201   The analytical control was based on extraction blanks and the recoveries of the

202   surrogate standards in all of the samples. Procedural blanks were performed for each

203   series of 11 samples, and the blank results were sufficiently low ($<$ 3 times the detection

204   limit) to not interfere with the analyses of the target compounds. The mean of the

205   analyte values in the blanks was subtracted from the samples.

206   The surrogate recoveries were considered satisfactory, with mean values of $62 \pm$

207   16% for eicosene and 84 ± 34% for 1-C_{12}-LAB for at least 80% of the samples

208   analyzed. Although reference material for the SPM was unavailable, regular analyses of

209   the reference material for sediment from the IAEA (International Atomic Energy

210   Agency, IAEA-408) showed satisfactory results for AHs, with recoveries for most of

211   the target compounds ranging from 90 to 110%. The detection limit (DL) for AHs was

212   0.004 µg L^{-1}, based on the lowest sensitive AH concentration (0.05 ng µL^{-1}) multiplied

213   by the final extracted volume (250 µL) and divided by the filtered water volume (3.5

214   L). The DL for LABs was 1.4 ng L^{-1}, based the lowest sensitive LAB concentration

215   (0.02 ng µL^{-1}) multiplied by the final extracted volume (250 µL) and divided by the

216   filtered water volume (3.5 L).

217

218   *3.3. Data analysis*

219   The data were treated using the QuantumGIS version 2.4.0 software (Nanni et

220   al., 2014) to create maps with the spatial distribution of the AHs and LABs. Statistical

221   analyses were performed and graphs were constructed using the R 3.0.3 software. To

222   evaluate the correlation between AHs and LABs, type II regression using Ordinary

223   Least Squares (OLS) method and Spearman correlation were performed. Based on the

224   AH and LAB concentrations, the non-parametric Kruskal-Wallis test was performed to

225 determine whether there is a significant difference (p-value < 0.05) in the organic

226 marker distributions among the sampling campaigns. Once a difference was observed,

227 the non-parametric Mann-Whitney test was used to determine the campaigns for which

228 the difference was observed (p-value < 0.1 = marginally significantly; p-value < 0.05 =

229 significantly).

230

231 **4. Results and Discussion**

232 *4.1. AH and LAB concentrations*

233   The quantitative results of the AH and LAB determinations in SPM are shown in

234 Tables 1 and 2, respectively. The total *n*-alkane concentrations by SPM weight ranged

235 from 2.7 to 109.0 $\mu g\ g^{-1}$ dry weight (mean = $25.8 \pm 19.3\ \mu g\ g^{-1}$). The total AH

236 concentrations by SPM weight ranged from 39.3 to 1591.4 $\mu g\ g^{-1}$ dry weight (mean =

237 $313.2 \pm 273.6\ \mu g\ g^{-1}$). These levels are over the same range as those found in other

238 coastal regions under anthropic influence, such as the Rio de La Plata estuary (Colombo

239 et al., 2007), Lake Tunis (Mzoughi and Chouba, 2011) and certain Chinese rivers (Guo

240 et al., 2010), and the levels are above those found in the Mundaú-Manguaba estuarine

241 system, which receives agricultural and urban sewage (Maioli et al., 2011). However,

242 due to the wide mangrove coverage, the hydrocarbons levels observed in Guaratuba Bay

243 may also be related to natural sources. These data are higher than those found in

244 environments distant from direct human influence, such as the continental shelf in

245 Papua New Guinea (Burns et al., 2008) and in Australia (Burns and Brinkman, 2011).

246 However, the data are one order of magnitude lower than the AH concentrations found

247 in an industrial zone in Malaysia (Bakhtiari et al., 2009) and in sewage sludge in France

248 (Mansuy-Huault et al., 2009), indicating an environment with a lower organic load.

249   The LAB concentrations by MPS weight ranged from below the detection limit

250   (<DL) to 3769.7 ng g^{-1} dry weight (mean = 906.7 ± 1031.0 µg g^{-1}). LABs are not

251   commonly studied, especially in the SPM, but the measurements found in this study are

252   one order of magnitude lower than those found in the Rio de La Plata estuary (Colombo

253   et al., 2007), in the Pearl River Delta (Ni et al., 2008) and in the sewage sludge (Luo et

254   al., 2008). This result suggests that Guaratuba Bay is less affected by sewage compared

255   with other environments under human influence.

256 Table 1. Concentrations of total *n*-alkanes and total aliphatic hydrocarbons (in µg g^{-1} dw) and diagnostic ratios in samples of surface suspended particulate matter from
257 Guaratuba Bay, SW Atlantic. C_{max} = the *n*-alkane with the highest concentration; Pri/Phy = ratio between pristane and phytane; Pri/*n*-C_{17} = ratio between pristane and the *n*-
258 alkane *n*-C_{17}; Phy/*n*-C_{18} = ratio between phytane and the *n*-alkane *n*-C_{18}; LMW/HMW = ratio between low molecular weight *n*-alkanes (*n*-C_{15} - *n*-C_{20}) and high molecular
259 weight *n*-alkanes (*n*-C_{27} - *n*-C_{32}).

Sampling	April 2013																					
Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
n-Alkanes	75.94	73.79	40.28	24.92	36.79	15.73	25.37	39.43	25.63	33.26	29.72	15.87	23.61	15.05	12.79	11.19	10.77	23.85	33.16	10.38	16.40	17.65
AHs	721.6	1162.0	451.0	373.6	346.1	145.5	322.3	753.1	407.9	636.9	401.4	222.1	138.0	98.9	256.2	231.2	235.0	219.6	219.6	229.4	303.7	218.94
% UCM	63.1	76.4	69.4	65.7	65.5	64.3	75.6	81.9	83.2	80.9	75.6	69.0	66.7	64.6	62.6	60.7	58.9	57.2	55.6	54.1	52.7	51.4
C_{max}	18	18	29	18	31	29	29	18	18	18	18	16	29	15	15	15	18	18	18	18	18	18
Pri/Phy	0.7	0.7	1.9	0.9	1.0	1.5	0.9	0.5	0.8	0.6	0.9	1.1	1.0	1.1	0.4	1.2	0.6	0.8	0.6	0.6	0.6	0.9
Pri/*n*-C_{17}	0.6	0.6	0.9	0.5	0.6	0.7	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.4	0.6	0.6	0.5	0.5	0.5	0.6	0.6
Phy/*n*-C_{18}	0.6	0.5	0.7	0.4	0.7	0.4	0.5	0.6	0.6	0.6	0.5	0.8	0.5	0.6	0.6	0.4	0.6	0.5	0.6	0.6	0.5	0.5
LMW/HMW	3.3	3.9	0.8	2.7	0.6	0.9	1.3	7.4	2.4	8.9	2.0	1.5	0.8	1.5	2.0	4.0	12.1	7.8	9.1	18.9	9.3	30.4
Sampling	August 2013																					
Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
n-Alkanes	38.21	109.05	18.82	28.53	24.10	23.05	21.34	36.55	26.03	32.26	25.59	25.00	25.05	19.10	8.04	16.56	7.29	11.62	14.29	11.02	6.50	21.86
AHs	557.0	490.0	184.5	329.5	175.8	107.7	189.3	448.3	208.9	511.7	238.5	249.3	252.3	157.3	94.5	146.9	79.8	105.5	103.5	138.2	140.7	240.7
% UCM	57.3	46.0	35.9	63.4	55.7	39.3	67.6	81.7	66.2	77.7	59.5	69.9	63.9	60.4	29.4	51.5	30.6	49.6	46.2	47.4	47.2	70.0
C_{max}	17	31	17	17	17	17	17	17	17	19	17	17	17	17	12	17	17	17	17	17	18	18
Pri/Phy	1.4	1.2	1.3	0.8	1.1	1.4	1.0	0.6	0.9	0.6	1.3	0.8	1.1	1.0	1.8	1.4	1.6	1.3	2.1	1.8	0.9	1.3
Pri/*n*-C_{17}	0.6	0.5	0.3	0.1	0.2	0.3	0.2	0.2	0.1	0.3	0.2	0.1	0.2	0.2	0.8	0.2	0.7	0.4	0.4	0.7	0.9	0.6
Phy/*n*-C_{18}	0.5	0.5	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.5	0.4
LMW/HMW	11.8	0.2	8.2	15.4	9.0	1.8	11.4	15.0	4.0	35.6	5.7	24.4	5.4	4.5	3.9	8.7	6.7	5.3	2.7	13.6	n.c.	10.1
Sampling	March 2014																					
Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
n-Alkanes	38.60	27.06	n.a.	33.81	88.84	22.20	41.77	40.80	n.a.	7.99	8.29	8.05	17.54	8.97	49.78	14.51	21.63	26.43	8.04	2.67	8.53	13.09
AHs	249.5	228.7	n.a.	188.4	1591.4	195.1	592.1	611.0	n.a.	77.4	39.3	101.6	137.6	82.6	1064.8	182.4	395.8	453.6	137.3	62.2	171.2	242.0

% UCM	3.0	55.1	n.a.	0.0	91.7	61.1	84.8	84.2	n.a.	55.0	0.0	31.5	50.2	66.3	90.3	72.5	86.3	85.1	71.6	40.5	82.0	86.7
C_{max}	17	17	n.a.	15	19	29	19	19	n.a.	17	29	15	29	29	19	19	19	19	19	15	19	19
Pri/Phy	1.2	2.5	n.a.	2.6	0.4	1.8	0.7	0.5	n.a.	1.8	1.8	1.3	1.8	1.4	0.3	0.9	0.5	0.5	0.8	1.7	0.7	0.6
Pri/n-C_{17}	0.3	0.6	n.a.	0.6	0.5	0.8	0.8	0.5	n.a.	0.7	0.6	0.5	0.7	0.6	0.6	0.7	0.6	0.8	0.5	0.8	0.7	0.6
Phy/n-C_{18}	0.7	0.7	n.a.	0.7	0.4	0.7	0.6	0.5	n.a.	0.7	0.9	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	1.5	0.6	0.5
LMW/HMW	2.8	1.2	n.a.	3.3	20.1	0.8	3.1	5.2	n.a.	1.5	1.2	3.5	0.9	1.0	30.5	1.8	10.8	9.1	4.7	11.0	n.c.	8.2

260   n.a.: not analyzed
261   n.c.: not calculated
262

263   Table 2. Concentrations of total linear alkylbenzenes (in ng g^{-1} dw) and diagnostic ratios in samples of surface suspended particulate matter from Guaratuba Bay, SW Atlantic.
264   I/E C_{12} = ratio between the internal and external isomers of C_{12}-LABs; I/E C_{13} = ratio between the internal and external isomers of C_{13}-LABs; C_{12} / C_{13} = ratio between the
265   combined abundance of C_{13}-LABs and C_{12}-LABs.

Sampling	**April 2013**																					
Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
LABs	2486.8	3769.7	838.6	830.7	722.9	247.3	760.4	645.6	710.7	834.4	1020.0	1281.1	607.0	512.3	212.2	152.0	325.0	407.4	394.6	174.6	514.0	388.9
% C_{10}	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% C_{11}	11.2	19.9	n.d.	n.d.	16.0	19.7	25.0	n.d.	23.3	6.2	25.7	20.4	30.0	29.6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% C_{12}	33.8	30.7	25.9	30.5	21.4	20.7	22.8	21.2	30.3	32.7	30.9	26.6	24.2	30.9	24.4	n.d.	12.7	19.5	12.4	n.d.	11.3	18.6
% C_{13}	55.0	49.4	74.1	69.5	62.6	59.6	52.2	78.8	46.4	61.1	43.4	53.0	45.8	39.5	75.6	100.0	87.3	80.5	87.6	100.0	88.7	81.4
I/E C_{12}	2.5	1.2	n.c.	2.8	n.c.	n.c.	n.c.	n.c.	1.0	1.2	1.2	1.4	2.7	1.1	n.c.	n.c.	n.c.	1.3	n.c.	n.c.	n.c.	1.2
I/E C_{13}	1.6	1.8	1.0	1.3	1.6	1.9	1.3	1.1	1.1	1.0	1.2	0.8	1.1	1.4	0.6	1.9	1.0	0.7	0.6	1.2	0.7	0.8
C_{12} / C_{13}	1.6	1.6	2.9	2.3	2.9	2.9	2.3	3.7	1.5	1.9	1.4	2.0	1.9	1.3	3.1	n.c.	6.9	4.1	7.1	n.c.	7.8	4.4
Sampling	**August 2013**																					
Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
LABs	3452.6	1919.7	983.8	1007.6	1969.4	1550.7	1365.2	1496.4	896.6	1665.6	716.4	1215.3	2179.9	771.0	709.8	685.9	463.9	1597.3	1437.0	446.0	438.0	1312.7
% C_{10}	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	2.3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% C_{11}	12.9	n.d.	n.d.	n.d.	4.8	21.2	4.5	6.4	16.0	4.4	n.d.	n.d.	18.5	5.2	7.0	n.d.	n.d.	21.7	28.1	n.d.	n.d.	12.7
% C_{12}	30.6	31.4	37.8	17.9	32.3	31.3	31.4	35.9	30.8	31.2	25.0	28.0	27.9	30.7	39.6	30.2	24.8	34.2	35.2	11.5	13.4	30.5

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
% C_{13}	56.5	68.6	62.2	82.1	62.9	47.5	64.1	57.7	53.2	64.4	75.0	72.0	51.3	64.1	53.4	69.8	75.2	44.1	36.7	88.5	86.6	56.8
I/E C_{12}	1.7	1.2	3.2	1.2	0.8	1.1	0.9	0.9	1.3	0.9	2.4	1.3	1.0	1.3	1.5	3.0	n.c.	1.1	1.4	n.c.	n.c.	0.9
I/E C_{13}	1.3	1.0	1.4	1.0	1.0	1.3	1.2	1.1	1.3	1.1	1.1	1.2	1.1	1.2	1.7	1.0	1.2	1.5	1.5	0.9	1.1	1.6
C_{12} / C_{13}	1.8	2.2	1.6	4.6	2.0	1.5	2.0	1.6	1.7	2.1	3.0	2.6	1.8	2.1	1.3	2.3	3.0	1.3	1.0	7.7	6.5	1.9
Sampling											**March 2014**											
Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
LABs	n.a.	908.0	n.a.	1196.4	1440.3	201.9	600.6	332.2	n.a.	35.5	26.8	n.d.	57.4	n.d.	480.8	27.1	85.8	92.7	10.4	5.9	46.6	46.6
% C_{10}	n.a.	8.6	n.a.	11.3	n.d.	n.d.	n.d.	n.d.	n.a.	n.d.	n.d.	n.c.	n.d.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% C_{11}	n.a.	36.4	n.a.	30.9	n.d.	n.d.	n.d.	n.d.	n.a.	n.d.	n.d.	n.c.	n.d.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% C_{12}	n.a.	9.4	n.a.	20.2	26.6	19.0	23.5	n.d.	n.a.	n.d.	n.d.	n.c.	n.d.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% C_{13}	n.a.	45.6	n.a.	37.6	73.4	81.0	76.5	100.0	n.a.	100.0	100.0	n.c.	100.0	n.c.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
I/E C_{12}	n.a.	n.c.	n.a.	1.1	0.7	n.c.	1.1	n.c.	n.a.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.
I/E C_{13}	n.a.	0.7	n.a.	n.c.	0.7	2.5	0.9	0.7	n.a.	n.c.	n.c.	n.c.	n.c.	n.c.	0.7	n.d.	0.4	0.6	n.c.	n.c.	0.7	0.5
C_{12} / C_{13}	n.a.	4.8	n.a.	1.9	2.8	4.3	3.3	n.c.	n.a.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.

266   n.a.: not analyzed
267   n.c.: not calculated
268   n.d.: not detected

269

270   *4.2. Spatial distribution*

271   In all of the sampling campaigns, the AH and LAB distributions were similar

272   (Fig. 2). The correlation between the AH and LAB concentrations may indicate that

273   they have the same sources (Fig. 3), as found by Ni et al. (2009), or that the transport

274   pathways are similar for these two groups of compounds (Ni et al., 2008).

275   In April 2013, the highest AH and LAB concentrations were found in the inner

276   sampling stations (#1 and #2) near Cubatão and São João Rivers (see location in Fig. 1),

277   suggesting an common source via fluvial transport (Spearman correlation = 0.64; *p*-

278   value = 0.002). In August 2013, both of the lipid markers showed a homogeneous

279   distribution, suggesting an absence of specific and precise sources (Spearman

280   correlation = 0.53; *p*-value = 0.012). In March 2014, high AH and LAB concentrations

281   were found near site #5, distant from anthropic influences (Spearman correlation = 0.81;

282   *p*-value = $3.5e^{-5}$). These high concentrations could be associated with the local

283   hydrodynamic and geochemical interactions, such as coagulation and flocculation of

284   dissolved hydrocarbons (Nemirovskaya, 2011). AH concentrations were also high at

285   site #15, near the Guaratuba dock. Therefore, boat traffic could be an important source

286   of petroleum hydrocarbons in this region, which can be corroborated by the elevated

287   PAH concentrations observed by Dauner et al. (submitted).

288
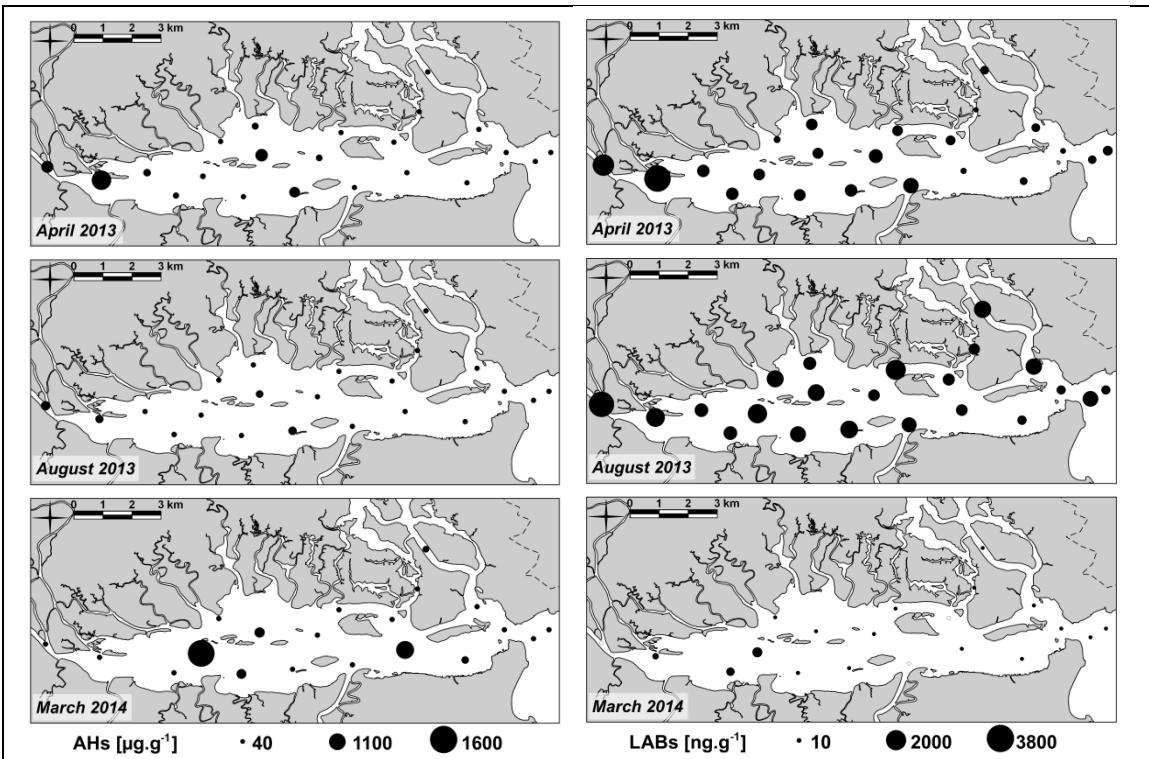
Fig. 2. Spatial distribution of the total AHs (in µg g^{-1}) and total LABs (in ng g^{-1}) on surficial suspended particulate matter from Guaratuba Bay, SW Atlantic.
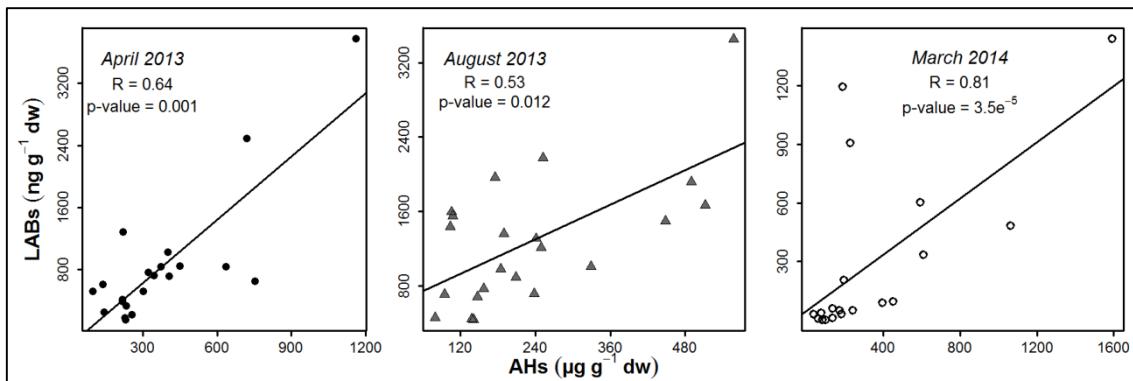
Fig. 3. Type II regression between AHs and LABs (in µg g^{-1} and ng g^{-1}, respectively) for each sampling campaign. R = Spearman Correlation.

Fig. 4 presents the AH and LAB concentrations *vs.* salinity. In all of the sampling campaigns, the highest AH and LAB values were found over the salinity range of 5 – 10 PSU. Initially, this result may suggest that the riverine flux is a possible source of hydrocarbons to Guaratuba Bay. Leonov and Nemirovskaya (2011) have described the three removal mechanisms of hydrocarbons in an estuary (gravitational, physicochemical and biological). Over the range of 5 – 10 PSU, the mixing between the

302 fresh riverine and the salty marine water may favor the flocculation and coagulation of

303 particles. Due to the physicochemical processes of organic compound sorption and

304 desorption, the dissolved forms pass to the particulate phase, creating a region of

305 accumulated biomarkers (Leonov and Nemirovskaya, 2011). In addition, they also

306 described the biological zone as the region where the increase in hydrocarbon

307 concentrations may be related to natural (biogenic) origin because of phytoplankton

308 synthesis. In Guaratuba Bay, the highest concentrations of chlorophyll-*a* were observed

309 in this region, indicating a peak of phytoplankton productivity (Cotovicz Junior et al.,

310 2013; Mizerkowski et al., 2012). It may suggest the biogenic (marine) HA origin could

311 explain the increase of hydrocarbon concentrations in the 5-10 PSU range. The second

312 AH peak is over the range of 15 – 20 PSU, but in this case, the high values appear to be

313 associated with local sources.

314
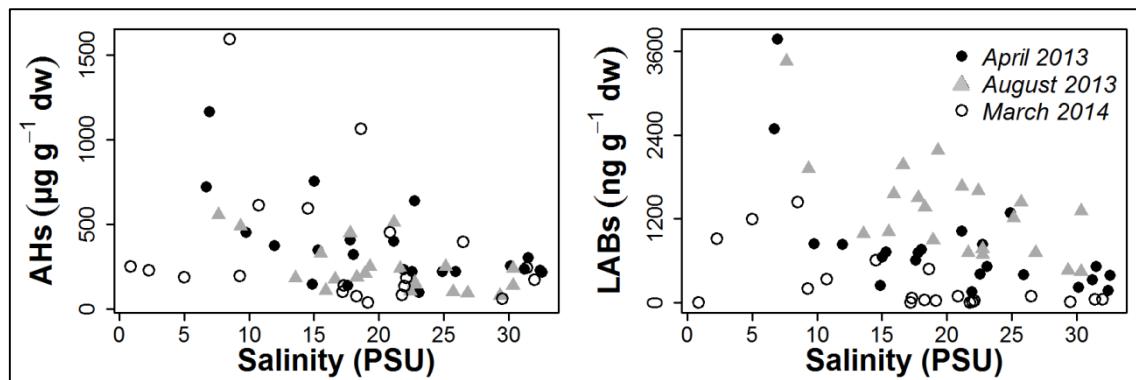
315
316 Fig. 4. Dispersion plot of AH and LAB concentrations (in µg g^{-1} and ng g^{-1}, respectively) *vs.* salinity (in
317 PSU).
318

319 *4.3. Temporal distribution*

320   One of the advantages of analyzing the SPM matrix is the capacity to evaluate

321 variations on a short time scale. The intensity of the anthropic influence varies

322 significantly over the year in Guaratuba Bay primarily because of the summer tourism.

323 During this period, the increase in the number of inhabitants causes intensification in

324   car and boat traffic and in non-treated sewage discharge (IAP, 2006; Kolm et al., 2007).

325   The Kruskal-Wallis test (Table 3) indicates that the AH and LAB contents varied

326   among the sampling campaigns.

327

328   Table 3. Results from the non-parametric analysis of variance between the sampling campaigns using the
329   Kruskal-Wallis test and the Mann-Whitney test. ° = Non-significant; * = Marginally significant; ** =
330   Significant.

Kruskal-Wallis Test			
Sampling Campaigns	**April 2013 – August 2013 – March 2014**		
AHs	p-value = 0.07797 *		
LABs	p-value = 2.254e-06 **		
Mann-Whitney Test			
Sampling Campaigns	**April 2013 – August 2013**	**April 2013 – March 2014**	**August 2013 – March 2014**
AHs	p-value = 0.0289 **	p-value = 0.0994 *	p-value = 0.9305 °
LABs	p-value = 0.0022 **	p-value = 0.0006 **	p-value = 1.1 e-6 **

331

332   For the total AHs, the differences occurred between the austral summer

333   campaigns (April 2013 and March 2014) and the winter campaign (August 2013), with

334   the highest mean values and widest ranges occurring during the austral summer (Fig. 5).

335   This result may be associated with the seasonal importance of tourism. In addition, the

336   high temperatures during summer favor biological productivity, possibly increasing the

337   production of biogenic hydrocarbons. The summer period is also the rainy season, with

338   rainfall amounts of 67.5 mm in April 2013 and 61.3 mm in March 2014, which are

339   extremely higher than the value of 1.2 mm in August 2013, comparing the ten days

340   prior to samplings (the residence time of Guaratuba Bay is approximately 9.3 days;

341   Marone et al., 2006). This input of a greater fresh water volume in the austral summer

342   also transports a higher quantity of organic and inorganic load from the watershed,

343   which can contain pollutants and increase the biological productivity.

344
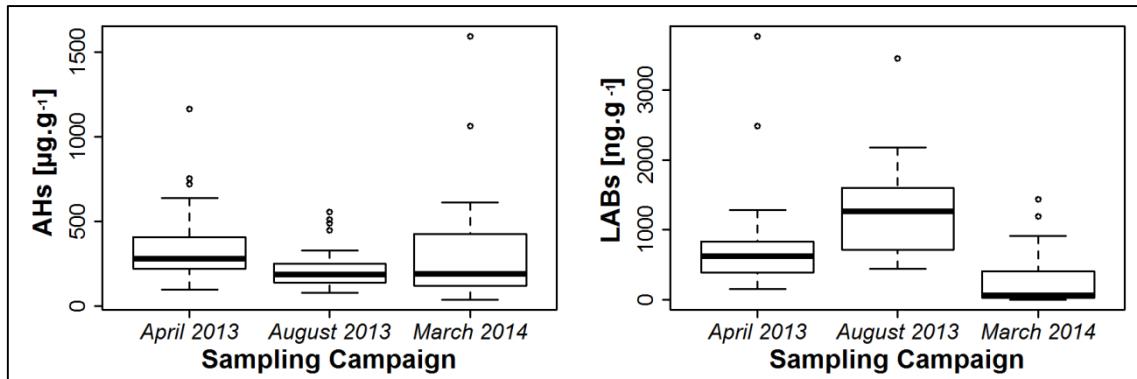
Fig. 5. Boxplots of AH and LAB concentrations (in µg g^{-1} and ng g^{-1}, respectively) for each sampling campaign.

The total LAB concentrations also varied significantly between the sampling stations, but in a distinct manner from the AH variation, suggesting different sources. The highest value was observed in April 2013, whereas the highest mean was observed in August 2013. Because LABs are indicative of sewage input (Takada and Eganhouse, 1998), the highest mean LAB concentration observed during the austral winter suggests that the input of sewage is relatively constant over the year, with local increases during the austral summer.

4.4. Evaluation of AH sources and degradation

The samples showed a wide variety of *n*-alkane distributions, revealing complex inputs of hydrocarbons (Fig. 6). Due to this variability of AH sources, Commendatore and Esteves (2004) have suggested the use of several evaluation indices (Tab. 1). One of the most common indices used to distinguish between the anthropic and biogenic AH origin is the Carbon Preference Index (CPI) (Aboul-Kassim and Simoneit, 1995; Wang et al., 2009). CPI is typically calculated based on high molecular weight (HMW) *n*-alkanes. However, a complementary evaluation of CPI based on low molecular weight (LMW) *n*-alkanes (Charriau et al., 2009; Colombo et al., 2007) is more representative in

366 samples with bimodal *n*-alkane profiles (Guo et al., 2011; Leonov and Nemirovskaya,

367 2011).

368

369 $$LMW\ CPI = 0.5 * (((C_{13} - C_{21})/(C_{12} - C_{20})) + ((C_{13} - C_{21})/(C_{14} - C_{22})))$$

370 $$HMW\ CPI = 0.5 * (((C_{25} - C_{33})/(C_{24} - C_{32})) + ((C_{25} - C_{33})/(C_{26} - C_{34})))$$

371
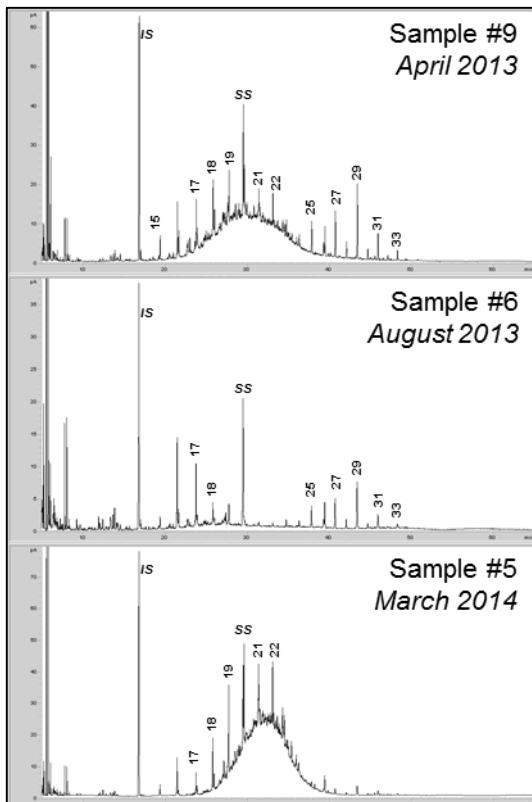
372
373 Fig. 6. Chromatograms of aliphatic hydrocarbons in three different SPM samples. IS = Internal standard;
374 SS = Surrogate standard.
375

376 Fig. 7 presents the distribution of LMW and HMW CPI in each sampling

377 campaign. If the evaluation was based only on the HMW CPI, then this index would

378 indicate a predominantly biogenic origin (Wang et al., 2009). However, the HMW CPI

379 presented higher values than the LMW CPI, suggesting that most of the samples have a

380 petrogenic source of LMW AHs and a biogenic source of HMW AHs (Colombo et al.,

381 2007). This trend is clearly observed in April 2013, when all of the samples presented

382 low LMW CPI and the majority of the samples showed the *n*-C$_{18}$ as the major *n*-alkane

383   (Table 1), indicating a predominance of petroleum LMW hydrocarbons. The

384   predominance of naphthalene and phenanthrene and its alkylated forms in the SPM

385   corroborates the petrogenic source of the hydrocarbons (Dauner et al., submitted). The

386   biogenic hydrocarbons, as evidenced by the high values of HMW CPI, the

387   predominance of the n-alkanes n-C_{29} and n-C_{31} in certain samples, and the low values of

388   the LMW/HMW ratio (Guo et al., 2011), can be derived from the mangrove forest in the

389   margins. This terrestrial source is especially observed during the austral summer, when

390   the precipitation rates are higher, thus transporting more particulate material from the

391   watershed. Finally, in August 2013, the major hydrocarbon found was n-C_{17}, and nearly

392   all of the samples presented high LMW/HMW ratios, suggesting an algae contribution

393   to the carbon pool (Colombo et al., 2007). This sampling campaign coincided with a dry

394   period when the fluvial influence into the bay was limited and the marine water could

395   reach the estuary inner portion.

396
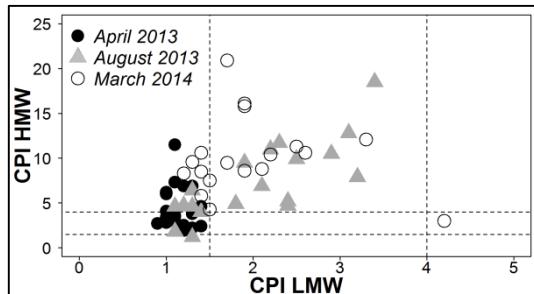
397
398   Fig. 7. Dispersion plot of LMW CPI *vs*. HMW CPI for each sampling campaign.
399

400   The presence of the unimodal Unresolved Complex Mixture (UCM) can also

401   confirm the petroleum origin of the LMW compounds. UCM was present in nearly all

402   of the samples and generally represented more than 50% of the AHs, especially during

403   the austral summer. The presence of UCM can be related to crude and weathered oils

404   (Mansuy-Huault et al., 2009; Wang et al., 1999), but according to Mansuy-Huault et al.

405   (2009), the bell shape observed over the range of n-C_{17} and n-C_{23} (Fig. 6) suggests the

406 presence of fuel oil. The oil may originate from the boat and ferry traffic in the bay and

407 from the vehicle traffic on the road that follows the São João River for more than 15

408 km, evidencing the importance of its increasing during the austral summer.

409   Finally, the presence of the isoprenoids pristane and phytane can also be used to

410 evaluate the petroleum contamination in an environment. Pristane can be formed by

411 biogenic processes, while phytane originates from petroleum hydrocarbons

412 (Commendatore and Esteves, 2004; Mzoughi and Chouba, 2011), and the

413 pristane/phytane ratio values close to 1.0 indicate the petroleum input in the majority of

414 the samples. Both of the compounds can also be used to determine the relative

415 biodegradation of *n*-alkanes because they are decomposed more slowly than the *n*-C_{17}

416 and *n*-C_{18} *n*-alkanes (Commendatore and Esteves, 2004; Short et al., 2007). Due to the

417 presence of relatively high concentrations of AHs, the low values of Pristane/*n*-C_{17} and

418 Phytane/ *n*-C_{18} indicate fresh oil inputs in all of the samples (Table 1).

419

420 *4.5. Evaluation of LAB degradation*

421   The relative composition of the LAB isomers can also be indicative of their

422 sources and degradation degree. Higher concentrations of C_{13}-LABs were found,

423 especially in March 2014, followed by isomers with 12 carbon atoms (C_{12}-LABs)

424 (Table 2). This result agrees with studies published by Martins et al. (2010) and Martins

425 et al. (2014) in other Brazilian estuaries and may reflect the use of surfactants with the

426 same composition in these regions.

427   Typically, the isomer composition can be used to determine the LAB

428 degradation rate using the ratio between their internal and external isomers (*I/E* ratio)

429 (Takada and Ishiwatari, 1990). Based on this parameter, calculated with C_{12}-LABs and

430 C_{13}-LABs, most of the samples presented recent inputs of LABs.

431   Luo et al. (2008) proposed a new indicator, C_{13}-LABs/C_{12}-LABs, to estimate the

432   LAB biodegradation in aquatic environments based on the combined abundance of C_{13}-

433   LABs and C_{12}-LABs in environmental samples compared with detergent solutions and

434   sewage sludge. Using this ratio, a greater number of samples collected in Guaratuba

435   Bay could be evaluated, and more than 60% of the samples presented values higher than

436   2.0, suggesting degradation processes. These processes can be observed especially

437   during the austral summer, when the highest values were recorded, and in the outermost

438   sampling sites.

439   The difference between the spatial degradation degrees is most likely due to the

440   exposure time in which the compounds remain in the water column from the source

441   (inner sites) to the estuary mouth. High values of the C_{13}-LABs/C_{12}-LABs ratio

442   observed during the austral summer are most likely due to the higher temperatures,

443   which favor microbial activity (Lalli and Parsons, 1997). This enhanced degradation

444   trend in the warmer months was also observed for AHs, with the highest values of the

445   pristane/n-C_{17} ratio also found in April 2013 and March 2014, corroborating the

446   preferential degradation of these organic compounds during the austral summer.

447   Another explanation to the highest LAB mean concentrations observed in

448   August 2013 could be the difference in precipitation rates and, consequently, in the

449   dilution by fluvial water. In August 2013, the rainfall was sixty times lower than in

450   summer months (April 2013 and March 2014). The high precipitation rates observed in

451   the summer could cause a dilution of the organic markers by fluvial and pluvial waters,

452   leading to the low values observed. On the opposite way, the low riverine flux observed

453   in August 2013 may generate an accumulation of LABs in the estuary, although the

454   LAB input has not necessarily been increased.

455

5. Summary and Conclusions

Through the determination of organic markers, AHs and LABs, adsorbed on SPM, it was possible to evaluate the spatial and short time scale variability of hydrocarbon inputs and composition in Guaratuba Bay. The spatial distribution of the compounds varied among the sampling campaigns.

Generally, the highest concentrations were observed during the austral summer, not refuting the hypothesis (ii) and highlighting the importance of increased human influence during summer holidays. However, the highest mean LAB values during the austral winter may be explained by the decreased microbial degradation rates due to low temperatures or the dilution by fluvial and pluvial waters during the austral summer. In all of the sampling campaigns, both lipid classes presented similar spatial trends, suggesting common transportation routes, such as the riverine flux in the inner portion of the estuary, partially accepting the hypothesis (i). The compound distributions were also affected by natural geochemical processes of organic matter accumulation.

LABs presented the same composition as that observed in other Brazilian estuaries, and AHs were associated with petroleum and biogenic sources. The introduction of fuel oil was observed, most likely originating from boat and vehicle traffic, along with signs of a biogenic input, most likely from the mangrove forest surrounding the bay and from autochthonous primary production. Finally, due to the low precipitation rates and the advance of salt water into the bay, it was possible to detect an autochthonous signal in August 2013.

The results of this study demonstrated that the introduction of sewage and oil could be considered an emergent problem for the Guaratuba Bay ecosystem. Although the concentrations are not comparable to severely polluted environments, they are already over the same range as that in more urbanized and industrialized regions. This

71

481 study also showed the importance of evaluating the contaminant inputs on a short time

482 scale and highlighted the need for sewage input monitoring programs in the upper

483 estuary and for boat maintenance inspections to avoid the release of crude oil, primarily

484 during the summer.

485

497

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POSFÁCIO

A partir da análise das distribuições espacial e temporal de hidrocarbonetos (HPAs, HAs e LABs) no MPS da Baía de Guaratuba foi possível identificar as suas principais fontes e verificar como os processos geoquímicos naturais e a flutuação populacional afetam as suas distribuições.

O somatório das concentrações de HPAs totais variaram entre 5,89 e 650,51 ng L^{-1}, enquanto o somatório das concentrações de HAs e LABs totais variaram entre 39,3 e 1591,4 µg g^{-1} e <DL (abaixo do limite de detecção) e 3769,7 ng g^{-1}, respectivamente. As concentrações de HPAs estão na mesma faixa de alguns ambientes costeiros já antropizados, como o litoral do Mar Mediterrâneo (França e Espanha; GUITART et al., 2007) e a laguna Manguaba (Brasil; MAIOLI et al., 2011), mas abaixo dos valores observados em regiões altamente urbanizadas e industrializadas, como o estuário do Rio Sarno (Itália; MONTUORI & TRIASSI, 2012) e o rio Daliao (China; GUO et al., 2007). Os valores de HAs estão na mesma faixa dos encontrados em outras regiões costeiras sob influência antrópica, como a estuário do Rio da Prata (Argentina e Uruguai; COLOMBO et al., 2007) e o lago de Tunis (Tunísia; MZOUGHI & CHOUBA, 2011), enquanto as concentrações de LABs são até uma ordem de magnitude inferiores às encontradas no estuário do Rio da Prata (Argentina a Uruguai; COLOMBO et al., 2007) e no delta do Rio Pearl (China; NI et al., 2008).

De um modo geral, foram observados altos valores na porção mediana do estuário, relacionados a processos físico-químicos que contribuem para o acúmulo de matéria orgânica (LEONOV & NEMIROVSKAYA, 2011). Nessa região, ocorre um aumento da área de seção da baía e o encontro de fluxos com direções opostas e características físicas distintas, o que favorece processos de floculação e adsorção de compostos orgânicos no MPS, gerando uma região atuante como um filtro geoquímico de partículas (BIANCHI, 2007).

Também foram observados altos valores de HPAs na desembocadura da baía, próximo à passagem de balsas, sugerindo uma introdução contínua de HPAs ao longo do ano. Já os HAs e os LABs apresentaram altos valores na porção mais interna da baía, sugerindo o aporte fluvial como fonte da introdução desses compostos. Por fim, foram observados altos valores de HPAs e de HAs próximo à marina de Guaratuba na coleta realizada durante o Carnaval (Março/2014), indicando um aumento da introdução desses

compostos nesse período. Ainda, as maiores concentrações foram observadas durante o verão, período de aumento populacional na região costeira.

A análise de razões diagnósticas permitiu avaliar as principais fontes dos hidrocarbonetos na Baía de Guaratuba. A predominância de HPAs da baixa massa molar e de compostos alquilados, como os alquilnaftalenos e alquilfenantrenos, indicou a presença de fontes petrogênicas (WANG et al., 1999), provavelmente associado ao tráfego de embarcações e balsas na baía, com alguns pontos de introdução pirolítica de HPAs.

Os HAs apresentaram múltiplas fontes, podendo ser associados tanto a fontes petrogênicas quanto naturais. A presença de MCNR unimodal, composta de n-alcanos de baixa massa molar (n-C_{17} – n-C_{23}) e os baixos valores do Índice Preferencial de Carbono (IPC ≈ 1) em 56% das amostras sugerem a presença de óleo combustível (COLOMBO et al., 2007), podendo estar associado ao tráfego de veículos e embarcações. No entanto, a distribuição dos n-alcanos de alta massa molar (n-C_{27} – n-C_{33}) com número ímpar de carbonos, além da presença de altas concentrações de perileno (em 64% das amostras), sugere a introdução de matéria orgânica proveniente de fontes biogênicas terrestres (READMAN et al., 2002; GUO et al., 2011), provavelmente oriundas da floresta de manguezal existente nas margens da baía. Os LABs apresentaram a mesma composição observada em outros estuários brasileiros (MARTINS et al., 2010, 2014), com predominância de n-C_{13}-LABs e n-C_{12}-LABs.

A predominância de HPAs alquilados e a as baixas concentrações de alcanos isoprenoides (pristano e fitano), se comparados aos n-alcanos correspondentes (n-C_{17} e n-C_{18}), indicam a introdução de material petrogênico recente (WANG et al., 1999; COMMENDATORE & ESTEVES, 2004). No entanto, as razões envolvendo LABs indicaram a presença de processos de degradação microbiana, especialmente durante o verão, provavelmente devido às maiores temperaturas (LUO et al., 2008).

Assim, foi possível observar que a introdução de óleo e esgoto são problemas emergentes na Baía de Guaratuba, especialmente durante os momentos de explosão populacional durante o verão, enfatizando assim a importância da avaliação de contaminantes em curtas escalas temporais. Também é importante considerar as características físico-químicas da coluna d'água em estudos de avaliação ambiental envolvendo o MPS, uma vez que eles podem ser responsáveis por acumular material orgânico em regiões afastadas de fontes pontuais de poluentes.

ANEXO – DADOS BRUTOS

Tabela 1. Parâmetros da coluna d'água da Baía de Guaratuba em Abril/2013.

Ponto	Lat	Long	Horário	T [°C]	Salin [USP]	Prof [m]	pH	OD [mL/L]	OD [% sat]	MPS [mg/L]
1	25° 51' 49,8" S	48° 43' 42,6" W	16h03	24,50	6,71	3,1	7,15	4,48	78,88	11,80
2	25° 52' 6,2" S	48° 42' 35,8" W	15h56	24,80	6,93	2,5	7,29	4,94	87,48	13,37
3	25° 51' 56,9" S	48° 41' 39,4" W	16h13	24,94	9,78	2,5	7,22	5,54	99,20	15,47
4	25° 52' 25,3" S	48° 41' 3,6" W	15h50	25,42	11,94	4,6	7,54	5,71	105,89	20,93
5	25° 52' 1,3" S	48° 40' 30,2" W	15h45	25,72	15,31	3,2	7,77	5,54	104,61	26,03
6	25° 51' 18,3" S	48° 40' 8,3" W	16h20	25,81	14,90	1,4	7,26	4,86	91,12	61,37
7	25° 52' 26,7" S	48° 39' 40,2" W	15h40	25,69	18,06	1,4	7,74	4,96	95,24	30,63
8	25° 51' 35,3" S	48° 39' 17,7" W	16h25	25,47	15,05	3,2	7,66	5,37	101,37	25,20
9	25° 50' 59,4" S	48° 39' 25,6" W	16h35	25,69	17,81	1,5	7,48	4,55	86,90	83,70
10	25° 52' 20,9" S	48° 38' 37,1" W	15h30	25,67	22,76	1,5	7,71	4,84	95,13	32,80
11	25° 51' 38,6" S	48° 38' 6,4" W	16h42	25,59	21,18	3,5	7,68	4,73	92,45	39,70
12	25° 52' 15,2" S	48° 37' 23,0" W	15h23	25,58	24,92	7,3	7,85	4,75	94,34	32,20
13	25° 51' 7,3" S	48° 37' 39,6" W	16h46	25,75	17,60	2,1	7,28	4,01	76,46	52,27
14	25° 51' 19,3" S	48° 36' 34,1" W	16h55	25,63	23,12	1,2	7,81	4,57	90,22	78,17
15	25° 51' 56,9" S	48° 36' 18,0" W	15h00	25,81	30,14	8	7,85	4,64	95,56	29,70
16	25° 50' 41,6" S	48° 36' 2,7" W	17h02	25,79	21,95	2	7,45	3,90	76,12	34,93
17	25° 52' 9,5" S	48° 35' 3,8" W	14h52	25,82	31,24	6,7	7,85	4,64	95,81	34,43
18	25° 49' 52,6" S	48° 35' 52,2" W	17h10	25,92	22,57	5	7,86	3,92	77,01	38,80
19	25° 51' 3,4" S	48° 34' 49,1" W	17h18	25,66	25,93	2,3	7,77	4,24	84,73	39,43
20	25° 51' 32,1" S	48° 34' 15,2" W	14h45	25,70	32,44	8,8	7,76	4,46	92,69	39,30
21	25° 51' 32,1" S	48° 33' 20,1" W	14h40	25,87	31,52	12,5	7,83	4,82	99,60	30,27
22	25° 51' 42,9" S	48° 33' 39,2" W	14h25	25,85	32,61	5,1	7,47	4,83	100,47	41,80

Tabela 2. Parâmetros da coluna d'água da Baía de Guaratuba em Agosto/2013.

Ponto	Lat	Long	Horário	T [°C]	Salin [USP]	Prof [m]	pH	OD [mL/L]	OD [% sat]	MPS [mg/L]
1	25° 51' 49,8" S	48° 43' 42,6" W	16h34	18,52	7,64	3,01	7,29	5,67	91,78	7,80
2	25° 52' 6,2" S	48° 42' 35,8" W	16h27	18,72	9,35	2,78	7,60	5,54	90,30	10,37
3	25° 51' 56,9" S	48° 41' 39,4" W	16h45	18,85	13,58	2,49	7,06	5,75	96,52	16,31
4	25° 52' 25,3" S	48° 41' 3,6" W	16h15	18,76	15,50	5,02	7,23	5,95	101,00	17,00
5	25° 52' 1,3" S	48° 40' 30,2" W	16h10	18,96	16,61	3,24	7,69	5,95	101,51	21,83
6	25° 51' 18,3" S	48° 40' 8,3" W	16h56	19,20	15,92	1,34	7,62	5,46	92,75	40,49
7	25° 52' 26,7" S	48° 39' 40,2" W	16h03	18,92	18,31	1,34	7,48	5,81	99,84	27,31
8	25° 51' 35,3" S	48° 39' 17,7" W	17h09	18,96	17,78	2,33	7,60	5,73	98,44	28,43
9	25° 50' 59,4" S	48° 39' 25,6" W	17h03	18,99	18,94	2,49	7,79	5,65	97,63	31,43
10	25° 52' 20,9" S	48° 38' 37,1" W	15h56	18,74	21,14	1,11	7,46	5,90	103,20	23,34
11	25° 51' 38,6" S	48° 38' 6,4" W	17h15	18,79	21,63	2,99	7,83	5,70	100,25	29,34
12	25° 52' 15,2" S	48° 37' 23,0" W	15h01	18,41	25,16	4,87	7,51	5,72	100,55	27,40
13	25° 51' 7,3" S	48° 37' 39,6" W	17h21	19,09	19,32	1,84	7,18	4,64	80,11	30,66
14	25° 51' 19,3" S	48° 36' 34,1" W	17h29	18,66	22,74	1,03	7,90	5,54	98,09	38,74
15	25° 51' 56,9" S	48° 36' 18,0" W	14h51	18,21	26,83	7,33	7,89	5,59	99,20	29,71
16	25° 50' 41,6" S	48° 36' 2,7" W	17h36	19,15	22,78	1,70	7,64	5,07	89,70	27,00
17	25° 52' 9,5" S	48° 35' 3,8" W	14h46	18,03	29,35	6,55	7,88	6,24	112,19	32,66
18	25° 49' 52,6" S	48° 35' 52,2" W	17h44	19,35	22,43	4,78	7,41	5,01	88,12	36,74
19	25° 51' 3,4" S	48° 34' 49,1" W	17h53	18,57	25,71	2,42	7,34	5,40	97,21	34,09
20	25° 51' 32,1" S	48° 34' 15,2" W	14h38	17,86	30,33	8,63	7,58	5,52	99,74	31,03
21	25° 51' 32,1" S	48° 33' 20,1" W	14h32	17,91	30,35	14,47	7,74	5,29	95,60	26,94
22	25° 51' 42,9" S	48° 33' 39,2" W	14h19	17,88	30,35	3,07	7,89	5,30	95,81	46,26

Tabela 3. Parâmetros da coluna d'água da Baía de Guaratuba em Agosto/2013.

Ponto	Lat	Long	Horário	T [°C]	Salin [UPS]	Prof [m]	pH	OD [mL/L]	OD [% sat]	MPS [mg/L]
1	25° 51' 49,8" S	48° 43' 42,6" W	7h47	24,90	0,85	2,73	6,56	4,34	75,61	10,00
2	25° 52' 6,2" S	48° 42' 35,8" W	7h39	25,44	2,30	1,46	7,32	4,30	75,38	23,80
3	25° 51' 56,9" S	48° 41' 39,4" W	7h59	25,43	2,73	1,55	8,09	4,19	73,96	15,00
4	25° 52' 25,3" S	48° 41' 3,6" W	7h28	25,99	5,02	4,05	6,81	4,35	79,00	12,57
5	25° 52' 1,3" S	48° 40' 30,2" W	7h20	26,36	8,49	2,06	7,00	4,33	79,97	25,06
6	25° 51' 18,3" S	48° 40' 8,3" W	8h08	26,27	9,29	< 0,20	6,95	3,53	65,64	38,29
7	25° 52' 26,7" S	48° 39' 40,2" W	7h06	26,53	14,54	< 0,20	7,23	3,90	76,24	54,54
8	25° 51' 35,3" S	48° 39' 17,7" W	8h30	26,44	10,74	0,81	7,10	3,96	74,51	32,06
9	25° 50' 59,4" S	48° 39' 25,6" W	*	*	*	*	*	*	*	*
10	25° 52' 20,9" S	48° 38' 37,1" W	6h58	26,82	18,28	0,95	7,35	3,94	78,31	69,31
11	25° 51' 38,6" S	48° 38' 6,4" W	6h50	26,86	19,17	2,83	7,41	3,91	78,19	52,97
12	25° 52' 15,2" S	48° 37' 23,0" W	6h44	26,51	17,21	7,36	7,43	4,06	80,24	31,69
13	25° 51' 7,3" S	48° 37' 39,6" W	8h45	26,32	17,33	0,95	7,12	3,62	70,45	40,43
14	25° 51' 19,3" S	48° 36' 34,1" W	8h53	26,85	21,81	0,21	7,62	4,24	86,20	105,56
15	25° 51' 56,9" S	48° 36' 18,0" W	6h36	26,20	18,63	6,98	7,36	4,15	81,51	31,11
16	25° 50' 41,6" S	48° 36' 2,7" W	9h00	26,54	22,13	< 0,20	7,37	3,52	71,61	52,37
17	25° 52' 9,5" S	48° 35' 3,8" W	6h28	26,67	26,49	5,25	7,83	4,10	85,28	59,00
18	25° 49' 52,6" S	48° 35' 52,2" W	9h10	26,52	20,87	4,26	7,28	3,22	65,12	48,66
19	25° 51' 3,4" S	48° 34' 49,1" W	9h20	26,83	22,00	1,69	7,59	3,78	76,89	76,14
20	25° 51' 32,1" S	48° 34' 15,2" W	6h20	26,68	29,51	9,56	8,05	4,20	89,28	66,54
21	25° 51' 32,1" S	48° 33' 20,1" W	6h01	26,71	32,01	9,79	8,04	4,41	94,86	70,46
22	25° 51' 42,9" S	48° 33' 39,2" W	6h12	26,74	31,40	2,13	8,02	4,43	94,84	102,37

* não coletado

Tabela 4. Concentrações (em ng.L^{-1}) de hidrocarbonetos policíclicos aromáticos (HPAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Abril/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HPAs (2-3 anéis)																						
naftaleno	<LD	<LD	<LD	<LD	<LD	6,32	<LD	27,09	3,11	8,59	<LD	<LD	<LD	4,30	<LD	<LD	<LD	2,44	20,51	<LD	<LD	<LD
bifenil	<LD	<LD	<LD	<LD	1,49	12,49	<LD	6,63	14,89	5,60	3,11	<LD	5,92	7,52	<LD	4,95	<LD	7,46	8,10	<LD	<LD	3,18
acenaftileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
acenafteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fluoreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,60	2,36	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,82	<LD	<LD	<LD
dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fenantreno	11,64	9,22	3,18	3,34	5,43	3,84	5,98	11,10	25,17	13,70	11,23	3,22	5,92	7,49	3,28	2,12	6,19	6,51	10,90	5,35	4,16	9,60
antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
HPAs (4-6 anéis)																						
fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,75	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
pireno	4,51	4,12	<LD	<LD	1,45	<LD	<LD	4,22	9,19	5,19	3,63	<LD	1,44	2,28	<LD	<LD	3,50	1,81	3,12	2,75	2,21	3,22
benzo(c)fenantreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(j+k)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(e)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
indeno [1,2,3-c,d]pireno	<LD	<LD	<LD	<LD	<LD	3,51	<LD	<LD	4,99	<LD	<LD	<LD	3,37	6,39	<LD	<LD	0,24	1,85	1,71	<LD	<LD	<LD
dibenzo(a,h)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(g,h,i)perileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
coroneno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

Alquil HPAs

2-metilnaftaleno	<LD	<LD	<LD	<LD	<LD	6,82	<LD	14,77	7,31	6,29	<LD	<LD	<LD	1,72	<LD	<LD	<LD	1,54	<LD	<LD	<LD	<LD
1-metilnaftaleno	<LD	<LD	<LD	<LD	<LD	4,08	<LD	8,82	4,08	4,09	<LD	<LD	<LD	1,42	<LD	<LD	<LD	<LD	5,90	<LD	<LD	<LD
C_2-naftaleno	<LD	<LD	<LD	<LD	<LD	19,02	<LD	24,76	34,64	16,26	<LD	<LD	2,91	12,42	<LD	4,21	<LD	15,69	21,92	<LD	4,45	5,68
C_3-naftaleno	3,49	2,57	1,48	<LD	1,61	5,53	2,07	6,34	12,20	4,69	4,26	1,45	4,16	5,46	<LD	2,53	<LD	5,14	6,95	<LD	<LD	3,37
C_1-fluoreno	10,83	8,53	3,92	5,78	6,82	7,92	5,54	28,82	38,26	23,68	11,57	4,50	8,39	9,91	4,25	5,42	6,86	14,94	26,73	8,55	5,88	14,98
C_1-dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fluoreno	19,79	13,85	2,65	2,66	5,86	2,48	5,43	16,18	45,12	21,03	17,09	2,78	7,08	7,85	2,99	<LD	13,16	9,24	18,39	12,36	6,63	17,35
C_1-fenantreno	39,08	33,89	6,33	6,57	13,87	4,18	13,07	37,59	77,70	44,96	31,60	5,48	11,57	13,31	7,39	1,79	23,58	15,33	30,32	23,36	16,46	30,29
C_2-dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,99	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fenantreno	40,00	35,67	4,61	5,02	10,58	2,28	9,88	37,18	74,81	43,87	27,23	4,44	8,68	11,42	5,67	<LD	28,33	12,39	24,86	26,78	17,83	27,97
C_1-fluoranteno	1,92	1,90	<LD	<LD	<LD	<LD	<LD	1,69	4,58	2,27	1,46	<LD	<LD	<LD	<LD	<LD	1,59	<LD	<LD	<LD	<LD	<LD
C_1-pireno	1,90	1,86	<LD	<LD	<LD	<LD	<LD	1,70	4,14	2,13	<LD	<LD	<LD	<LD	<LD	<LD	1,48	<LD	<LD	<LD	<LD	<LD
C_1-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

Naturais

reteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,80	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
perileno	<LD	<LD	<LD	<LD	<LD	3,51	<LD	<LD	4,99	<LD	<LD	<LD	3,37	6,39	<LD	<LD	<LD	1,85	1,71	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método (1,4 ng.L^{-1})

Tabela 5. Concentrações (em ng.L^{-1}) de hidrocarbonetos policíclicos aromáticos (HPAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Agosto/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HPAs (2-3 anéis)																						
naftaleno	<LD	<LD	10,64	10,58	4,30	4,04	6,70	10,46	4,29	52,82	18,41	<LD	1,66	<LD	<LD	3,01	3,39	2,06	<LD	23,96	<LD	11,80
bifenil	<LD	<LD	3,00	1,78	<LD	<LD	1,59	3,09	<LD	9,98	5,48	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	4,23	<LD	6,88
acenaftileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,56	<LD	5,81	2,65	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
acenafteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fluoreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fenantreno	2,08	1,62	1,45	1,63	2,78	8,93	3,19	4,78	3,94	3,41	3,40	2,00	3,19	2,95	1,44	1,84	1,57	2,39	2,20	1,66	1,77	5,40
antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
HPAs (4-6 anéis)																						
fluoranteno	<LD	<LD	<LD	<LD	<LD	1,95	<LD	1,64	<LD	1,67	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
pireno	<LD	<LD	<LD	<LD	<LD	2,48	<LD	5,35	2,16	5,17	1,69	1,85	2,10	1,77	<LD	<LD	<LD	<LD	<LD	<LD	<LD	3,47
benzo(c)fenantreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(j+k)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(e)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
indeno [1,2,3-c,d]pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
dibenzo(a,h)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(g,h,i)perileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
coroneno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

Alquil HPAs

2-metilnaftaleno	<LD	<LD	11,95	1,99	<LD	<LD	<LD	<LD	<LD	16,31	7,31	<LD	2,31	<LD	<LD	2,80	3,34	2,80	<LD	21,64	3,47	16,53
1-metilnaftaleno	<LD	<LD	4,17	2,11	<LD	<LD	<LD	1,86	<LD	10,29	4,95	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	6,85	<LD	4,47
C_2-naftaleno	<LD	<LD	13,52	8,01	<LD	<LD	1,67	6,51	<LD	31,29	19,20	<LD	3,27	<LD	<LD	2,46	4,33	3,30	<LD	18,71	2,63	20,79
C_3-naftaleno	1,68	<LD	1,57	1,94	<LD	3,54	<LD	<LD	<LD	1,91	2,21	<LD	1,71	1,70	<LD	1,41	1,57	1,95	1,80	2,41	1,42	6,38
C_1-fluoreno	4,56	2,82	2,58	3,15	3,62	6,87	4,37	4,96	3,65	5,74	4,48	2,63	4,66	3,53	2,76	2,89	3,96	5,53	4,28	3,95	3,39	18,46
C_1-dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fluoreno	2,04	<LD	<LD	1,99	1,46	3,35	2,09	11,54	4,41	8,48	2,37	3,53	4,97	3,47	<LD	1,58	<LD	1,46	1,50	<LD	1,64	6,27
C_1-fenantreno	5,30	3,33	2,37	4,70	3,37	7,36	4,95	26,10	10,89	20,52	5,94	8,51	11,23	8,75	1,69	3,40	1,58	3,14	3,25	3,41	3,54	15,77
C_2-dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fenantreno	5,63	3,13	2,11	4,49	2,14	3,93	3,57	34,20	10,77	31,13	4,76	10,80	11,10	8,42	<LD	2,46	<LD	2,19	2,28	3,45	3,98	18,65
C_1-fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	2,15	<LD	2,19	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_1-pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	2,20	<LD	2,16	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_1-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

Naturais

reteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
perileno	<LD	<LD	<LD	<LD	<LD	1,99	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	6,69

<LD = abaixo do limite de detecção do método (1,4 ng.L^{-1})

Tabela 6. Concentrações (em ng.L^{-1}) de hidrocarbonetos policíclicos aromáticos (HPAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Março/2014.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HPAs (2-3 anéis)																						
naftaleno	26,60	11,74	20,61	2,14	5,66	4,02	3,13	4,00	na	10,01	5,10	4,62	4,76	5,26	26,92	2,14	2,57	na	4,53	3,94	2,26	1,85
bifenil	4,79	2,32	6,03	<LD	<LD	<LD	<LD	<LD	na	2,75	<LD	<LD	<LD	<LD	7,27	<LD	<LD	na	<LD	<LD	<LD	<LD
acenaftileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
acenafteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
fluoreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
fenantreno	3,60	3,86	2,48	1,94	18,00	4,93	16,35	6,88	na	4,67	2,16	1,82	3,85	5,72	7,44	4,15	6,49	na	4,54	1,60	4,83	6,66
antraceno	<LD	4,92	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
HPAs (4-6 anéis)																						
fluoranteno	<LD	<LD	<LD	<LD	5,90	<LD	4,21	2,71	na	<LD	<LD	<LD	<LD	<LD	8,18	1,71	5,30	na	<LD	<LD	2,02	2,97
pireno	<LD	<LD	<LD	<LD	28,46	1,81	20,31	13,99	na	1,71	<LD	<LD	<LD	1,66	34,26	5,53	18,70	na	4,25	<LD	10,81	16,70
benzo(c)fenantreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(a)antraceno	<LD	<LD	<LD	<LD	1,50	<LD	1,68	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	3,25
criseno	<LD	<LD	<LD	<LD	2,60	<LD	3,00	2,67	na	<LD	<LD	<LD	<LD	<LD	5,87	<LD	5,08	na	<LD	<LD	<LD	4,54
benzo(b)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(j+k)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(e)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(a)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
indeno [1,2,3-c,d]pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
dibenzo(a,h)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(b)criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(g,h,i)perileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
coroneno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD

Alquil HPAs

2-metilnaftaleno	33,53	18,00	32,88	4,73	10,84	8,50	5,94	8,72	na	21,32	10,68	8,16	7,98	10,74	43,93	8,98	5,18	na	9,77	7,34	5,16	7,12
1-metilnaftaleno	8,38	3,63	9,18	<LD	1,48	<LD	<LD	<LD	na	4,17	<LD	<LD	<LD	1,68	13,66	<LD	<LD	na	<LD	<LD	<LD	<LD
C_2-naftaleno	23,48	14,07	40,92	<LD	5,34	3,63	8,73	1,45	na	16,61	3,10	<LD	<LD	8,62	45,69	5,87	<LD	na	4,36	<LD	<LD	1,74
C_3-naftaleno	3,80	3,53	3,89	1,81	4,07	3,41	5,74	2,18	na	4,69	2,39	1,93	3,15	6,00	3,48	2,29	1,73	na	2,82	1,59	1,49	2,48
C_1-fluoreno	5,45	5,44	4,02	2,48	17,18	5,64	11,98	4,85	na	5,84	2,50	2,74	3,72	6,28	7,66	3,18	3,85	na	3,66	1,75	3,27	5,16
C_1-dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
C_2-fluoreno	3,95	4,55	2,01	1,79	47,28	6,25	37,21	20,98	na	5,53	1,69	1,66	3,78	5,82	38,84	8,03	22,81	na	6,74	1,40	13,06	21,93
C_1-fenantreno	6,40	6,38	3,07	2,93	104,99	9,89	83,01	44,15	na	7,98	2,72	2,34	5,74	8,42	84,50	18,35	51,15	na	16,54	2,40	33,03	46,55
C_2-dibenzotiofeno	<LD	<LD	<LD	<LD	3,72	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	5,07	<LD	2,97	na	<LD	<LD	1,93	2,68
C_2-fenantreno	5,20	4,66	2,00	2,57	202,08	9,78	145,41	104,34	na	6,84	2,05	1,75	4,71	6,40	252,67	34,78	145,64	na	25,62	2,39	73,92	123,63
C_1-fluoranteno	<LD	<LD	<LD	<LD	20,45	<LD	14,81	13,22	na	<LD	<LD	<LD	<LD	<LD	33,87	3,63	20,76	na	1,49	<LD	6,75	19,49
C_1-pireno	<LD	<LD	<LD	<LD	18,02	<LD	13,28	10,30	na	<LD	<LD	<LD	<LD	<LD	28,58	3,23	16,77	na	1,50	<LD	6,22	15,31
C_1-criseno	<LD	<LD	<LD	<LD	<LD	<LD	1,63	1,43	na	<LD	<LD	<LD	<LD	<LD	2,73	<LD	2,74	na	<LD	<LD	<LD	2,73
C_2-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD

Naturais

reteno	<LD	<LD	<LD	<LD	6,73	<LD	4,35	3,49	na	<LD	<LD	<LD	<LD	<LD	8,38	<LD	5,13	na	<LD	<LD	1,91	3,13
perileno	2,95	8,48	1,80	<LD	2,04	2,95	6,90	1,93	na	6,80	4,92	<LD	1,44	6,14	<LD	3,09	<LD	na	4,25	<LD	<LD	3,09

<LD = abaixo do limite de detecção do método (1,4 ng.L^{-1})

na = não analisada.

Obs. 1: a amostra 9 não pode ser coletada.

Obs. 2: a amostra 18 foi descartada devido à má recuperação

Tabela 7. Concentrações (em ng.g^{-1}) de hidrocarbonetos policíclicos aromáticos (HPAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Abril/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HPAs (2-3 anéis)																						
naftaleno	< LD	<LD	<LD	<LD	<LD	100,58	<LD	1052,20	36,38	258,19	<LD	<LD	<LD	54,45	<LD	<LD	<LD	60,79	497,39	<LD	<LD	<LD
bifenil	<LD	<LD	<LD	<LD	56,74	198,83	<LD	257,42	174,32	168,28	77,01	<LD	108,14	95,25	<LD	137,74	<LD	186,02	196,38	<LD	<LD	70,95
acenaftileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
acenafteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fluoreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	62,15	27,63	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	44,14	<LD	<LD	<LD
dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fenantreno	974,64	685,14	197,69	155,87	207,25	61,15	190,10	431,19	294,73	411,94	278,36	97,91	108,20	94,91	104,36	59,03	170,05	162,40	264,38	131,96	132,24	214,42
antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
HPAs (4-6 anéis)																						
fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	20,49	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
pireno	377,63	306,16	<LD	<LD	55,34	<LD	<LD	163,93	107,61	156,06	89,98	<LD	26,32	28,89	<LD	<LD	96,15	45,15	75,68	67,83	70,25	71,92
benzo(c)fenantreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(j+k)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(e)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
indeno [1,2,3-c,d]pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
dibenzo(a,h)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(g,h,i)perileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

coroneno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

Alquil HPAs

2-metilnaftaleno	<LD	<LD	<LD	<LD	<LD	108,55	<LD	573,62	85,56	189,03	<LD	<LD	<LD	21,75	<LD	<LD	<LD	38,33	<LD	<LD	<LD	<LD
1-metilnaftaleno	<LD	<LD	<LD	<LD	<LD	65,02	<LD	342,75	47,81	123,08	<LD	<LD	<LD	18,04	<LD	<LD	<LD	<LD	143,19	<LD	<LD	<LD
C_2-naftaleno	<LD	<LD	<LD	<LD	<LD	302,81	<LD	961,69	405,58	488,82	<LD	<LD	53,12	157,34	<LD	117,13	<LD	391,33	531,59	<LD	141,36	126,79
C_3-naftaleno	292,50	191,22	92,21	<LD	61,58	88,11	65,91	246,41	142,90	141,12	105,68	44,19	76,09	69,23	<LD	70,54	<LD	128,31	168,65	<LD	<LD	75,35
C_1-fluoreno	906,82	633,86	243,69	269,73	260,31	126,11	176,11	1119,53	448,01	712,03	286,79	136,84	153,34	125,58	135,23	150,91	188,46	372,70	648,34	210,89	186,92	334,59
C_1-dibenzo tiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fluoreno	1657,06	1029,19	164,74	124,13	223,66	39,49	172,62	628,52	528,34	632,35	423,62	84,54	129,40	99,48	95,14	<LD	361,54	230,51	446,05	304,86	210,76	387,52
C_1-fenantreno	3272,25	2518,37	393,52	306,60	529,39	66,56	415,49	1460,21	909,84	1351,89	783,29	166,64	211,46	168,66	235,14	49,84	647,80	382,43	735,41	576,18	523,25	676,55
C_2-dibenzo tiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	23,30	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fenantreno	3349,28	2650,64	286,59	234,27	403,82	36,31	314,08	1444,28	876,00	1319,12	674,96	135,01	158,64	144,71	180,41	<LD	778,30	309,09	602,98	660,54	566,80	624,73
C_1-fluoranteno	160,77	141,19	<LD	<LD	<LD	<LD	<LD	65,65	53,63	68,26	36,19	<LD	<LD	<LD	<LD	<LD	43,68	<LD	<LD	<LD	<LD	<LD
C_1-pireno	159,09	138,22	<LD	<LD	<LD	<LD	<LD	66,04	48,48	64,05	<LD	<LD	<LD	<LD	<LD	<LD	40,66	<LD	<LD	<LD	<LD	<LD
C_1-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

Naturais

reteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	21,08	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
perileno	<LD	<LD	<LD	<LD	<LD	55,89	<LD	<LD	58,43	<LD	<LD	<LD	61,59	80,97	<LD	<LD	<LD	46,15	41,48	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método.

XC

Tabela 8. Concentrações (em ng.g^{-1}) de hidrocarbonetos policíclicos aromáticos (HPAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Agosto/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HPAs (2-3 anéis)																						
naftaleno	<LD	<LD	651,98	622,16	196,84	99,71	245,17	367,82	136,39	2262,65	627,30	<LD	54,04	<LD	<LD	111,36	103,70	55,97	<LD	772,08	<LD	255,02
bifenil	<LD	<LD	183,68	104,51	<LD	<LD	58,09	108,58	<LD	427,40	186,64	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	136,22	<LD	148,66
acenaftileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	54,76	<LD	248,76	90,20	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
acenafteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fluoreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
fenantreno	266,67	156,20	88,88	95,88	127,36	220,57	116,79	168,14	125,36	146,08	115,87	72,99	104,05	76,14	48,46	68,15	48,08	65,05	64,54	53,50	65,69	116,74
antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
HPAs (4-6 anéis)																						
fluoranteno	<LD	<LD	<LD	<LD	<LD	48,17	<LD	57,69	<LD	71,54	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
pireno	<LD	<LD	<LD	<LD	<LD	61,26	<LD	188,19	68,73	221,48	57,59	67,52	68,50	45,69	<LD	<LD	<LD	<LD	<LD	<LD	<LD	75,02
benzo(c)fenantreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(j+k)fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(e)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(a)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
indeno [1,2,3-c,d]pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
dibenzo(a,h)antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(b)criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
benzo(g,h,i)perileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

coroneno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Alquil HPAs																						
2-metilnaftaleno	<LD	<LD	732,28	116,86	<LD	<LD	<LD	<LD	<LD	698,57	249,01	<LD	75,24	<LD	<LD	103,58	102,17	76,11	<LD	697,31	128,67	357,28
1-metilnaftaleno	<LD	<LD	255,81	124,31	<LD	<LD	<LD	65,54	<LD	440,96	168,81	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	220,87	<LD	96,71
C_2-naftaleno	<LD	<LD	828,52	470,98	<LD	<LD	61,02	228,88	<LD	1340,31	654,22	<LD	106,55	<LD	<LD	90,99	132,49	89,72	<LD	602,89	97,49	449,37
C_3-naftaleno	215,81	<LD	96,44	114,31	<LD	87,52	<LD	<LD	<LD	81,97	75,43	<LD	55,89	43,97	<LD	52,35	48,18	53,16	52,91	77,78	52,83	138,00
C_1-fluoreno	584,62	271,90	158,14	185,29	165,84	169,69	159,99	174,47	116,14	245,90	152,68	95,99	152,00	91,11	92,88	107,04	121,26	150,51	125,57	127,30	125,82	399,07
C_1-dibenzo tiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fluoreno	261,54	<LD	<LD	117,06	66,88	82,75	76,52	405,93	140,32	363,28	80,77	128,83	162,12	89,56	<LD	58,52	<LD	39,74	44,01	<LD	60,87	135,55
C_1-fenantreno	679,49	321,07	145,27	276,47	154,38	181,79	181,22	918,09	346,50	879,07	202,43	310,58	366,31	225,85	56,88	125,93	48,38	85,46	95,35	109,90	131,39	340,92
C_2-dibenzo tiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-fenantreno	721,79	301,79	129,33	264,12	98,04	97,07	130,70	1203,02	342,68	1333,60	162,22	394,16	362,07	217,33	<LD	91,11	<LD	59,60	66,89	111,19	147,72	403,18
C_1-fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	75,63	<LD	93,82	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_1-pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	77,39	<LD	92,53	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_1-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
C_2-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Naturais																						
reteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
perileno	<LD	<LD	<LD	<LD	<LD	49,15	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	144,63

<LD = abaixo do limite de detecção do método.

Tabela 9. Concentrações (em ng.g^{-1}) de hidrocarbonetos policíclicos aromáticos (HPAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Março/2014.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HPAs (2-3 anéis)																						
naftaleno	2659,67	493,14	1329,46	169,96	225,75	104,91	57,32	124,67	na	144,37	96,22	145,70	117,66	51,26	865,09	40,80	43,50	na	59,45	59,16	32,03	18,04
bifenil	478,67	97,34	388,82	<LD	<LD	<LD	<LD	<LD	na	39,63	<LD	<LD	<LD	<LD	233,55	<LD	<LD	na	<LD	<LD	<LD	<LD
acenaftileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
acenafteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	7,57	6,93	4,29	11,25	4,58	3,90	na	3,81	3,76	2,84	2,25
fluoreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	13,57	11,87	7,90	20,89	8,21	6,27	na	7,35	6,46	4,83	4,20
dibenzotiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
fenantreno	360,00	162,18	160,00	154,32	718,36	128,77	299,76	214,62	na	67,37	40,78	57,44	95,23	55,78	239,12	79,24	110,00	na	59,62	24,04	68,55	65,06
antraceno	<LD	206,72	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
HPAs (4-6 anéis)																						
fluoranteno	<LD	<LD	<LD	<LD	235,46	<LD	77,19	84,54	na	<LD	<LD	<LD	<LD	<LD	262,90	32,65	89,83	na	<LD	<LD	28,67	29,01
pireno	<LD	<LD	<LD	<LD	1135,80	47,28	372,37	436,41	na	24,67	<LD	<LD	<LD	16,19	1101,10	105,59	316,95	na	55,82	<LD	153,43	163,13
benzo(c) fenantreno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(a) antraceno	<LD	<LD	<LD	<LD	59,86	<LD	30,80	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	31,75
criseno	<LD	<LD	<LD	<LD	103,76	<LD	55,00	83,29	na	<LD	<LD	<LD	<LD	<LD	188,66	<LD	86,10	na	<LD	<LD	<LD	44,35
benzo(b) fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(j+k) fluoranteno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(e)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(a)pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
indeno [1,2,3-c,d]pireno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
dibenzo(a,h) antraceno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(b)criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
benzo(g,h,i) perileno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD

Coroneno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD

Alquil HPAs

2-metilnaftaleno	3352,67	756,16	2121,08	375,98	432,48	221,93	108,84	271,91	na	307,54	201,56	257,42	197,30	104,70	1411,78	171,40	87,74	na	128,27	110,25	73,19	69,52
1-metilnaftaleno	838,33	152,66	592,47	<LD	59,20	<LD	<LD	<LD	na	60,21	<LD	<LD	7,50	16,42	439,13	<LD	<LD	na	<LD	<LD	<LD	<LD
C_2-naftaleno	2347,67	591,04	2639,78	<LD	212,98	94,73	160,00	45,13	na	239,59	58,46	<LD	<LD	84,03	1468,35	112,02	<LD	na	57,22	<LD	<LD	16,96
C_3-naftaleno	380,33	148,46	251,18	144,24	162,56	89,15	105,30	68,11	na	67,71	45,18	61,02	78,00	58,54	111,95	43,79	29,38	na	37,08	23,94	21,19	24,26
C_1-fluoreno	545,00	228,57	259,35	197,27	685,63	147,31	219,64	151,29	na	84,25	47,20	86,47	92,01	61,24	246,19	60,72	65,25	na	48,07	26,30	46,41	50,40
C_1-dibenzo tiofeno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD
C_2-fluoreno	395,00	191,18	129,68	142,39	1886,89	163,25	682,22	654,46	na	79,78	31,90	52,39	93,50	56,76	1248,30	153,33	386,61	na	88,52	21,04	185,36	214,22
C_1-fenantreno	64,00	268,07	198,06	233,07	4190,02	258,32	1521,92	1377,23	na	115,13	51,35	73,85	141,98	82,11	2715,79	350,38	866,95	na	217,22	36,07	468,80	454,72
C_2-dibenzo tiofeno	<LD	<LD	<LD	<LD	148,46	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	162,95	<LD	50,34	na	<LD	<LD	27,39	26,18
C_2-fenantreno	52,00	195,80	129,03	204,43	8064,77	255,45	2665,98	3254,81	na	98,68	38,70	55,23	116,50	62,41	8120,71	664,10	2468,47	na	336,47	35,92	1049,15	1207,66
C_1-fluoranteno	<LD	<LD	<LD	<LD	816,13	<LD	271,53	412,39	na	<LD	<LD	<LD	<LD	<LD	1088,57	69,31	351,86	na	19,57	<LD	95,80	190,39
C_1-pireno	<LD	<LD	<LD	<LD	719,16	<LD	243,48	321,30	na	<LD	<LD	<LD	<LD	<LD	918,55	61,67	284,24	na	19,70	<LD	88,28	149,55
C_1-criseno	<LD	<LD	<LD	<LD	<LD	<LD	29,88	44,61	na	<LD	<LD	<LD	<LD	<LD	87,74	<LD	46,44	na	<LD	<LD	<LD	26,67
C_2-criseno	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD

Naturais

Reteno	<LD	<LD	<LD	<LD	268,59	<LD	79,75	108,87	na	<LD	<LD	<LD	<LD	<LD	269,33	<LD	86,95	na	<LD	<LD	27,11	30,57
Perileno	295,00	356,30	116,13	<LD	81,41	77,05	126,51	60,20	na	98,10	92,88	<LD	35,62	59,88	<LD	59,00	<LD	na	55,82	<LD	<LD	30,18

<LD = abaixo do limite de detecção do método.
na = não analisada.
Obs. 1: a amostra 9 não pode ser coletada.
Obs. 2: a amostra 18 foi descartada devido à má recuperação.

Tabela 10. Concentrações (em µg.L^{-1}) de hidrocarbonetos alifáticos (HAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Abril/2013. Alif. Res. = Alifáticos Resolvidos; Alif. Tot. = Alifáticos Totais; MCNR = Mistura Complexa Não Resolvida.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alcanos																						
n-C$_{10}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD	<LD	0,01	<LD	0,02	0,07	<LD	<LD	<LD
n-C$_{11}$	0,01	0,02	0,01	0,01	0,01	0,01	0,01	<LD	<LD	0,01	0,01	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{12}$	0,01	0,01	0,01	0,01	0,01	0,01	0,01	<LD	0,01	0,01	0,01	0,01	0,02	0,02	0,01	<LD	0,01	0,01	0,02	0,01	0,01	0,01
n-C$_{13}$	0,02	0,02	0,02	0,02	0,02	0,04	0,03	0,02	0,05	0,02	0,05	0,02	0,10	0,10	0,02	0,02	<LD	0,02	<LD	<LD	<LD	0,02
n-C$_{14}$	0,01	0,01	<LD	<LD	<LD	0,01	<LD	<LD	0,04	<LD	0,03	<LD	0,06	0,06	<LD	0,01	<LD	0,01	0,03	0,01	<LD	<LD
n-C$_{15}$	0,05	0,04	0,03	0,03	0,04	0,06	0,05	0,03	0,12	0,04	0,09	0,05	0,11	0,14	0,05	0,08	0,05	0,11	0,09	0,05	0,04	0,09
n-C$_{16}$	0,08	0,07	0,04	0,05	0,05	0,09	0,06	0,07	0,17	0,07	0,11	0,06	0,11	0,10	0,04	0,07	0,02	0,12	0,14	0,02	0,05	0,07
n-C$_{17}$	0,09	0,10	0,06	0,06	0,06	0,08	0,06	0,14	0,25	0,16	0,11	0,05	0,07	0,09	0,02	0,04	0,04	0,14	0,22	0,05	0,06	0,14
n-C$_{18}$	0,13	0,17	0,04	0,09	0,06	0,08	0,08	0,23	0,31	0,26	0,14	0,04	0,08	0,09	0,04	0,05	0,06	0,19	0,32	0,08	0,10	0,17
n-C$_{19}$	0,11	0,12	0,02	0,02	0,04	0,03	0,04	0,20	0,22	0,20	0,08	0,02	0,03	0,04	0,02	0,01	0,06	0,11	0,22	0,07	0,08	0,13
n-C$_{20}$	0,05	0,06	0,01	0,01	0,02	0,01	0,02	0,05	0,11	0,07	0,04	0,01	0,02	0,02	0,01	<LD	0,03	0,02	0,04	0,03	0,03	0,04
n-C$_{21}$	0,03	0,04	0,01	0,01	0,01	0,01	0,02	0,03	0,06	0,05	0,03	0,01	0,01	0,01	0,02	<LD	0,02	0,02	0,01	0,02	0,02	0,02
n-C$_{22}$	0,04	0,04	0,01	0,01	0,02	0,01	0,02	0,04	0,08	0,05	0,04	0,01	0,02	0,02	0,01	0,01	0,03	0,03	0,03	0,02	0,02	0,03
n-C$_{23}$	0,02	0,02	0,01	0,01	0,01	0,02	0,01	0,02	0,04	0,02	0,02	0,01	0,02	0,02	0,01	0,01	0,01	0,02	0,01	0,01	0,01	0,01
n-C$_{24}$	0,02	0,03	0,02	0,02	0,01	0,01	0,02	0,02	0,03	0,02	0,02	0,01	0,02	0,02	0,01	<LD	0,02	0,01	0,01	0,01	0,01	0,01
n-C$_{25}$	0,02	0,04	0,04	0,02	0,03	0,06	0,03	0,03	0,08	0,03	0,04	0,02	0,06	0,05	0,02	0,01	0,02	0,04	0,03	0,01	0,02	0,02
n-C$_{26}$	0,02	0,03	0,04	0,02	0,03	0,02	0,02	0,02	0,03	0,02	0,03	0,02	0,02	0,03	0,02	0,01	0,02	0,01	0,02	0,02	0,02	0,01
n-C$_{27}$	0,03	0,03	0,05	0,02	0,05	0,09	0,05	0,02	0,12	0,02	0,06	0,03	0,12	0,08	0,02	0,02	0,01	0,03	0,03	0,01	0,01	0,01
n-C$_{28}$	0,02	0,02	0,04	0,01	0,05	0,03	0,03	0,01	0,04	0,01	0,03	0,02	0,04	0,03	0,02	<LD	<LD	0,01	0,01	<LD	0,01	<LD
n-C$_{29}$	0,04	0,04	0,07	0,03	0,09	0,16	0,09	0,03	0,20	0,03	0,11	0,04	0,23	0,13	0,02	0,03	0,01	0,03	0,05	0,01	0,01	0,01
n-C$_{30}$	0,02	0,01	0,03	0,01	0,08	0,03	0,02	0,01	0,03	0,01	0,02	0,02	0,03	0,02	0,01	<LD	<LD	<LD	0,01	<LD	<LD	<LD
n-C$_{31}$	0,04	0,03	0,04	0,02	0,09	0,07	0,05	0,02	0,09	0,02	0,06	0,03	0,07	0,05	0,02	0,01	<LD	0,01	0,02	<LD	0,01	<LD
n-C$_{32}$	0,01	0,01	0,02	0,01	0,07	0,01	0,01	<LD	0,02	0,01	0,01	0,01	0,01	0,01	0,01	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{33}$	0,02	0,02	0,02	0,02	0,06	0,04	0,03	0,01	0,05	0,01	0,03	0,02	0,04	0,03	0,01	0,01	0,01	0,01	0,01	<LD	0,01	0,01

$n\text{-}C_{34}$	0,01	<LD	0,02	0,01	0,03	0,02	0,02	0,01	0,02	<LD	0,02	0,01	0,01	0,02	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{35}$	0,02	0,02	0,02	0,02	0,02	0,02	0,02	<LD	0,03	<LD	0,02	<LD	0,02	0,02	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{36}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{37}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{38}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{39}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{40}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Pristano	0,06	0,06	0,05	0,03	0,04	0,05	0,04	0,07	0,14	0,09	0,06	0,03	0,04	0,05	0,01	0,02	0,02	0,07	0,11	0,03	0,03	0,08
Fitano	0,08	0,09	0,03	0,04	0,04	0,03	0,04	0,15	0,17	0,14	0,07	0,03	0,04	0,05	0,02	0,02	0,04	0,09	0,19	0,04	0,05	0,09
Somas																						
Alif. Res.	3,18	3,69	2,22	2,74	3,13	3,26	2,48	3,51	5,85	4,04	3,96	2,27	2,52	2,77	3,02	3,27	3,52	3,77	4,02	4,27	4,52	4,77
Alif. Tot.	8,62	15,64	7,25	8,01	9,07	9,14	10,14	19,39	34,84	21,18	16,19	7,30	7,55	7,80	8,05	8,30	8,55	8,80	9,05	9,30	9,55	9,80
MCNR	5,44	11,95	5,03	5,26	5,94	5,87	7,66	15,87	28,99	17,14	12,23	5,04	5,04	5,04	5,04	5,04	5,04	5,04	5,04	5,04	5,04	5,04

<LD = abaixo do limite de detecção do método (0,004 µg.L^{-1}).

Tabela 11. Concentrações (em µg.L^{-1}) de hidrocarbonetos alifáticos (HAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Agosto/2013. Alif. Res. = Alifáticos Resolvidos; Alif. Tot. = Alifáticos Totais; MCNR = Mistura Complexa Não Resolvida.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alcanos																						
n-C$_{10}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	0,03	<LD	<LD	<LD	<LD	<LD	<LD	0,03	<LD	0,02
n-C$_{11}$	0,03	0,01	0,01	<LD	0,01	0,02	0,01	<LD	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,01	0,01	0,01	0,02	<LD	<LD	0,01
n-C$_{12}$	0,02	0,01	0,01	0,01	0,02	0,04	0,02	0,01	0,03	0,01	0,01	0,01	0,01	0,03	0,03	0,02	0,02	0,02	0,02	0,01	0,02	0,01
n-C$_{13}$	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	<LD	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	<LD	0,02	0,02
n-C$_{14}$	<LD	<LD	<LD	<LD	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD	0,01	<LD	0,02
n-C$_{15}$	0,02	0,02	0,02	0,01	0,02	0,04	0,02	0,02	0,03	0,02	0,02	0,02	0,03	0,04	0,02	0,02	0,02	0,02	0,02	0,03	0,01	0,04
n-C$_{16}$	0,03	0,02	0,02	0,03	0,03	0,06	0,03	0,03	0,04	0,03	0,03	0,03	0,05	0,04	0,02	0,02	0,02	0,03	0,04	0,03	0,01	0,09
n-C$_{17}$	0,05	0,05	0,08	0,17	0,17	0,19	0,23	0,31	0,27	0,16	0,30	0,26	0,25	0,22	0,03	0,17	0,04	0,09	0,10	0,07	0,02	0,19
n-C$_{18}$	0,05	0,04	0,04	0,06	0,08	0,09	0,09	0,15	0,07	0,15	0,08	0,09	0,09	0,07	0,02	0,04	0,04	0,06	0,04	0,05	0,03	0,22
n-C$_{19}$	0,03	0,02	0,05	0,10	0,09	0,07	0,10	0,25	0,11	0,21	0,12	0,15	0,10	0,08	0,01	0,07	0,02	0,07	0,05	0,04	0,02	0,13
n-C$_{20}$	0,01	0,01	<LD	0,01	0,01	<LD	0,01	0,06	0,02	0,05	0,01	0,02	0,02	0,01	<LD	0,01	<LD	<LD	<LD	0,01	0,01	0,03
n-C$_{21}$	0,01	0,01	<LD	0,01	0,01	0,01	0,01	0,03	0,01	0,03	0,01	0,01	0,01	0,01	<LD	0,01	<LD	0,01	0,01	0,01	0,01	0,02
n-C$_{22}$	0,01	0,01	<LD	0,01	0,01	0,01	0,01	0,04	0,01	0,03	0,01	0,01	0,01	0,01	<LD	0,01	<LD	<LD	<LD	<LD	0,01	0,02
n-C$_{23}$	<LD	0,01	<LD	<LD	0,01	0,01	<LD	0,01	0,01	0,01	0,01	<LD	0,01	0,01	<LD	0,01	<LD	0,01	0,01	<LD	<LD	0,01
n-C$_{24}$	0,01	0,01	<LD	0,01	<LD	0,01	<LD	0,01	<LD	0,01	0,01	0,01	0,01	0,01	<LD	<LD	<LD	0,01	0,01	<LD	<LD	0,01
n-C$_{25}$	0,01	0,01	0,01	0,01	0,01	0,04	0,01	0,01	0,02	0,01	0,02	0,01	0,02	0,02	0,01	0,01	0,01	0,01	0,02	0,01	0,01	0,02
n-C$_{26}$	0,01	0,02	0,01	0,01	0,01	0,01	<LD	0,01	0,01	<LD	0,01	0,01	0,01	0,01	0,01	<LD	<LD	0,01	0,01	0,01	0,01	0,02
n-C$_{27}$	0,01	0,04	0,01	0,01	0,01	0,06	0,01	0,01	0,03	<LD	0,03	0,01	0,03	0,03	0,01	0,01	0,01	0,02	0,02	0,01	<LD	0,02
n-C$_{28}$	<LD	0,06	<LD	<LD	<LD	0,01	<LD	<LD	0,01	<LD	<LD	<LD	0,01	<LD	<LD	<LD	<LD	<LD	0,01	<LD	<LD	0,01
n-C$_{29}$	0,01	0,12	0,01	0,01	0,02	0,11	0,02	0,02	0,07	0,01	0,05	0,01	0,05	0,05	0,01	0,02	0,01	0,02	0,04	0,01	<LD	0,03
n-C$_{30}$	<LD	0,16	<LD	<LD	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{31}$	<LD	0,20	0,01	<LD	0,01	0,04	0,01	0,01	0,03	<LD	0,02	0,01	0,01	0,02	0,01	<LD	<LD	0,01	0,02	<LD	<LD	0,01
n-C$_{32}$	<LD	0,17	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{33}$	<LD	<LD	0,01	0,01	0,01	0,03	0,01	0,01	0,02	0,01	0,01	0,01	<LD	0,01	0,01	0,01	0,01	0,01	0,02	0,01	<LD	0,01

XCVII

$n\text{-}C_{34}$	<LD	0,07	0,01	<LD	<LD	0,01	<LD	0,01	0,01	<LD	<LD	<LD	<LD	0,01	0,01	<LD	0,01	0,01	0,01	0,01	<LD	0,01
$n\text{-}C_{35}$	<LD	0,04	<LD	<LD	<LD	0,02	<LD	<LD	0,02	<LD	<LD	<LD	<LD	0,02	0,02	<LD	0,02	0,01	0,02	0,02	<LD	0,02
$n\text{-}C_{36}$	<LD	0,02	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{37}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{38}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{39}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{40}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Pristano	0,03	0,03	0,02	0,02	0,04	0,05	0,04	0,05	0,03	0,05	0,05	0,04	0,05	0,04	0,02	0,03	0,03	0,03	0,04	0,05	0,01	0,12
Fitano	0,02	0,02	0,02	0,03	0,04	0,03	0,04	0,08	0,03	0,08	0,04	0,05	0,04	0,04	0,01	0,02	0,02	0,03	0,02	0,03	0,02	0,09
Somas																						
Alif. Res.	1,86	2,74	1,93	2,05	1,70	2,65	1,67	2,33	2,22	2,66	2,83	2,05	2,80	2,41	1,98	1,93	1,81	1,95	1,90	2,26	2,00	3,34
Alif. Tot.	4,34	5,08	3,01	5,60	3,84	4,36	5,17	12,74	6,56	11,95	7,00	6,83	7,74	6,09	2,81	3,97	2,61	3,88	3,53	4,29	3,79	11,13
MCNR	2,49	2,34	1,08	3,55	2,14	1,71	3,50	10,42	4,35	9,28	4,17	4,78	4,94	3,68	0,82	2,04	0,80	1,92	1,63	2,03	1,79	7,79

<LD = abaixo do limite de detecção do método (0,004 µg.L^{-1}).

Tabela 12. Concentrações (em µg.L^{-1}) de hidrocarbonetos alifáticos (HAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Março/2014. Alif. Res. = Alifáticos Resolvidos; Alif. Tot. = Alifáticos Totais; MCNR = Mistura Complexa Não Resolvida.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alcanos																						
n-C$_{10}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{11}$	<LD	0,01	na	0,03	0,01	0,02	0,03	0,01	na	<LD	0,01	0,02	0,04	0,02	<LD	0,01	0,03	0,02	<LD	0,02	0,01	0,01
n-C$_{12}$	0,01	0,01	na	0,04	0,01	0,03	0,04	0,03	na	0,01	0,03	0,03	0,06	0,04	0,01	0,02	0,05	0,04	0,02	0,04	0,03	0,03
n-C$_{13}$	0,02	0,02	na	0,02	0,02	0,02	0,02	0,02	na	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
n-C$_{14}$	<LD	<LD	na	0,01	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	0,01	0,01	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{15}$	0,04	0,07	na	0,08	0,09	0,11	0,14	0,11	na	0,08	0,08	0,06	0,11	0,11	0,03	0,07	0,05	0,05	0,06	0,06	0,08	0,08
n-C$_{16}$	0,04	0,07	na	0,03	0,06	0,02	0,04	0,01	na	0,03	0,02	0,01	0,03	0,03	0,02	0,02	0,01	0,01	0,02	0,01	0,01	0,02
n-C$_{17}$	0,07	0,08	na	0,06	0,15	0,06	0,14	0,07	na	0,07	0,04	0,03	0,04	0,08	0,04	0,05	0,04	0,04	0,07	0,01	0,04	0,07
n-C$_{18}$	0,03	0,03	na	0,02	0,41	0,04	0,30	0,13	na	0,04	0,01	0,01	0,02	0,04	0,17	0,06	0,11	0,13	0,08	<LD	0,07	0,14
n-C$_{19}$	0,02	0,03	na	0,01	0,62	0,04	0,41	0,25	na	0,03	0,01	0,01	0,02	0,04	0,47	0,10	0,23	0,29	0,11	<LD	0,13	0,28
n-C$_{20}$	0,01	0,01	na	0,02	0,29	0,01	0,21	0,17	na	0,01	<LD	<LD	0,01	0,01	0,28	0,05	0,17	0,19	0,04	<LD	0,08	0,17
n-C$_{21}$	0,01	0,01	na	0,01	0,16	0,01	0,17	0,12	na	0,01	0,01	<LD	0,01	0,02	0,21	0,04	0,20	0,17	0,03	<LD	0,05	0,15
n-C$_{22}$	0,01	0,01	na	0,01	0,20	0,01	0,17	0,11	na	0,01	0,01	<LD	0,01	0,01	0,17	0,04	0,14	0,12	0,03	<LD	0,05	0,14
n-C$_{23}$	0,01	0,01	na	0,01	0,03	0,02	0,03	0,03	na	0,01	0,01	<LD	0,01	0,02	0,04	0,02	0,04	0,03	0,01	<LD	0,01	0,04
n-C$_{24}$	0,01	<LD	na	0,01	0,01	0,01	0,04	0,03	na	0,01	0,01	<LD	0,01	0,01	0,04	0,01	0,05	0,03	0,01	<LD	0,01	0,04
n-C$_{25}$	0,01	0,01	na	0,01	0,03	0,05	0,05	0,02	na	0,03	0,02	0,01	0,02	0,05	0,01	0,03	0,03	0,02	0,02	<LD	0,01	0,02
n-C$_{26}$	<LD	0,01	na	0,01	0,01	0,01	0,01	0,01	na	0,01	0,01	<LD	0,01	0,01	0,01	0,01	<LD	0,01	0,01	<LD	<LD	<LD
n-C$_{27}$	0,01	0,02	na	0,02	0,02	0,09	0,08	0,03	na	0,04	0,04	0,01	0,06	0,09	<LD	0,05	0,02	0,02	0,02	<LD	<LD	0,02
n-C$_{28}$	<LD	<LD	na	<LD	<LD	0,02	0,02	0,01	na	0,01	0,01	<LD	0,02	0,02	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{29}$	0,03	0,08	na	0,03	0,04	0,16	0,19	0,06	na	0,07	0,06	0,02	0,13	0,15	0,02	0,10	0,03	0,04	0,04	0,01	<LD	0,04
n-C$_{30}$	<LD	0,01	na	<LD	<LD	0,01	0,01	0,01	na	<LD	<LD	<LD	0,01	0,01	<LD	0,01	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{31}$	0,03	0,12	na	0,02	0,02	0,05	0,10	0,03	na	0,03	0,02	0,01	0,04	0,05	0,01	0,03	0,01	0,01	0,02	<LD	<LD	0,02
n-C$_{32}$	<LD	0,01	na	<LD	<LD	<LD	0,01	0,01	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{33}$	0,02	0,04	na	0,01	0,02	0,03	0,05	0,02	na	0,02	0,01	0,01	0,02	0,03	0,01	0,02	0,01	0,01	0,01	<LD	0,01	0,02

XCIX

n-C$_{34}$	0,01	<LD	na	<LD	0,01	0,01	0,01	0,01	na	0,01	0,01	<LD	0,01	0,01	<LD	0,01	0,01	0,01	<LD	<LD	<LD	0,01
n-C$_{35}$	0,02	<LD	na	<LD	0,02	0,02	0,02	0,02	na	0,02	0,02	<LD	<LD	0,02	<LD	0,02	0,02	0,02	0,02	<LD	<LD	0,02
n-C$_{36}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{37}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{38}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{39}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{40}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Pristano	0,02	0,05	na	0,03	0,08	0,05	0,11	0,03	na	0,05	0,02	0,01	0,03	0,04	0,02	0,03	0,02	0,03	0,04	0,01	0,03	0,04
Fitano	0,02	0,02	na	0,01	0,17	0,03	0,17	0,06	na	0,03	0,01	0,01	0,02	0,03	0,10	0,04	0,05	0,07	0,05	0,01	0,04	0,07
Somas																						
Alif. Res.	2,42	2,44	na	2,37	3,32	2,91	4,92	3,10	na	2,42	2,08	2,21	2,77	2,85	3,21	2,62	3,20	3,29	2,97	2,46	2,17	3,30
Alif. Tot.	2,49	5,44	na	2,37	39,88	7,47	32,29	19,59	na	5,36	2,08	3,22	5,56	8,46	33,13	9,55	23,35	22,07	10,46	4,14	12,06	24,77
MCNR	0,07	3,00	na	<LD	36,56	4,56	27,37	16,48	na	2,95	<LD	1,01	2,79	5,62	29,92	6,93	20,15	18,79	7,48	1,68	9,90	21,47

<LD = abaixo do limite de detecção do método (0,004 µg.L^{-1}).
na = não analisada
Obs. 1: a amostra 3 não pode ser analisada.
Obs. 2: a amostra 9 não pode ser coletada.

C

Tabela 13. Concentrações (em µg.g^{-1}) de hidrocarbonetos alifáticos (HAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Abril/2013. Alif. Res. = Alifáticos Resolvidos; Alif. Tot. = Alifáticos Totais; MCNR = Mistura Complexa Não Resolvida.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alcanos																						
$n\text{-}C_{10}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	0,31	<LD	<LD	<LD	<LD	<LD	<LD	<LD	0,36	<LD	0,45	1,58	<LD	<LD	<LD
$n\text{-}C_{11}$	0,84	1,19	0,50	0,51	0,31	0,08	0,16	0,16	<LD	0,30	0,22	0,12	0,09	<LD	<LD	<LD	<LD	0,10	<LD	<LD	<LD	<LD
$n\text{-}C_{12}$	0,59	0,82	0,44	0,37	0,31	0,13	0,29	<LD	0,09	0,27	0,20	0,27	0,33	0,20	0,22	<LD	0,19	0,22	0,39	0,22	0,25	0,16
$n\text{-}C_{13}$	2,01	1,71	1,31	0,93	0,80	0,56	0,79	0,78	0,63	0,63	1,14	0,58	1,81	1,31	0,57	0,58	<LD	0,52	<LD	<LD	<LD	0,38
$n\text{-}C_{14}$	0,84	0,52	<LD	<LD	<LD	0,16	<LD	<LD	0,50	<LD	0,67	<LD	1,01	0,73	<LD	0,31	<LD	0,30	0,75	0,17	<LD	<LD
$n\text{-}C_{15}$	3,94	2,97	2,05	1,45	1,56	0,99	1,65	1,20	1,41	1,05	2,31	1,43	1,92	1,79	1,50	2,12	1,29	2,62	2,23	1,23	1,34	2,01
$n\text{-}C_{16}$	6,61	4,83	2,61	2,15	2,02	1,48	1,94	2,68	2,01	2,23	2,78	1,85	1,94	1,24	1,15	2,06	0,47	2,97	3,40	0,52	1,62	1,65
$n\text{-}C_{17}$	7,70	7,58	3,48	2,71	2,33	1,21	2,00	5,28	2,88	4,75	2,75	1,46	1,28	1,13	0,76	1,03	1,10	3,39	5,31	1,21	1,84	3,19
$n\text{-}C_{18}$	10,80	12,41	2,24	4,20	2,10	1,31	2,61	8,93	3,64	7,67	3,45	1,09	1,48	1,10	1,18	1,31	1,68	4,67	7,64	1,90	3,12	3,77
$n\text{-}C_{19}$	8,96	8,84	1,06	1,03	1,68	0,45	1,24	7,57	2,59	5,89	1,91	0,70	0,58	0,47	0,73	0,31	1,54	2,72	5,34	1,80	2,48	2,86
$n\text{-}C_{20}$	4,35	4,24	0,68	0,61	0,92	0,11	0,76	2,02	1,29	2,07	1,04	0,30	0,27	0,22	0,45	<LD	0,93	0,57	0,90	0,81	0,86	0,78
$n\text{-}C_{21}$	2,34	2,97	0,44	0,37	0,34	0,13	0,54	1,20	0,74	1,38	0,67	0,24	0,20	0,16	0,51	0,11	0,49	0,37	0,32	0,37	0,64	0,42
$n\text{-}C_{22}$	3,27	3,20	0,68	0,61	0,61	0,14	0,70	1,51	0,93	1,50	0,92	0,33	0,29	0,24	0,41	0,14	0,69	0,62	0,63	0,57	0,73	0,74
$n\text{-}C_{23}$	1,26	1,63	0,81	0,56	0,31	0,32	0,45	0,66	0,46	0,51	0,50	0,36	0,35	0,29	0,29	0,14	0,30	0,45	0,27	0,20	0,38	0,20
$n\text{-}C_{24}$	1,42	2,15	1,24	0,70	0,50	0,19	0,57	0,74	0,36	0,63	0,55	0,40	0,27	0,24	0,41	0,11	0,41	0,32	0,32	0,25	0,45	0,27
$n\text{-}C_{25}$	1,84	3,20	2,18	1,07	0,95	0,94	1,05	1,05	0,96	0,81	1,09	0,70	1,04	0,67	0,60	0,36	0,47	0,90	0,61	0,27	0,67	0,38
$n\text{-}C_{26}$	1,84	2,15	2,36	0,98	1,18	0,30	0,73	0,62	0,29	0,48	0,72	0,64	0,42	0,33	0,67	0,31	0,41	0,22	0,44	0,47	0,57	0,18
$n\text{-}C_{27}$	2,43	2,45	3,05	1,03	1,87	1,39	1,56	0,93	1,35	0,63	1,59	0,88	2,21	0,98	0,60	0,53	0,25	0,85	0,80	0,17	0,41	0,18
$n\text{-}C_{28}$	1,67	1,49	2,24	0,51	1,95	0,49	0,86	0,47	0,47	0,30	0,74	0,64	0,69	0,41	0,48	0,11	<LD	0,12	0,17	<LD	0,25	<LD
$n\text{-}C_{29}$	3,68	3,12	4,10	1,40	3,55	2,60	2,77	1,24	2,39	0,84	2,68	1,34	4,24	1,61	0,73	0,86	0,22	0,85	1,16	0,22	0,35	0,20
$n\text{-}C_{30}$	1,42	0,89	1,74	0,42	3,05	0,40	0,76	0,35	0,36	0,24	0,57	0,49	0,48	0,29	0,35	<LD	<LD	<LD	0,15	<LD	<LD	<LD
$n\text{-}C_{31}$	2,93	2,08	2,61	0,93	3,55	1,05	1,56	0,58	1,04	0,45	1,36	0,76	1,26	0,65	0,48	0,19	0,11	0,35	0,44	<LD	0,19	0,09
$n\text{-}C_{32}$	0,75	0,37	0,93	0,28	2,63	0,16	0,41	0,16	0,18	0,18	0,30	0,33	0,20	0,16	0,29	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{33}$	1,93	1,56	1,49	0,75	2,21	0,59	0,89	0,50	0,57	0,42	0,77	0,52	0,64	0,42	0,41	0,25	0,22	0,25	0,34	<LD	0,25	0,18

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n-C$_{34}$	1,09	<LD	0,99	0,61	1,18	0,24	0,48	0,47	0,20	<LD	0,37	0,43	0,24	0,19	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{35}$	1,42	1,41	1,06	0,75	0,88	0,33	0,60	<LD	0,29	<LD	0,45	<LD	0,37	0,23	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{36}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{37}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{38}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{39}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{40}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Pristano	4,94	4,38	3,05	1,45	1,41	0,81	1,21	2,87	1,69	2,68	1,54	0,94	0,73	0,67	0,29	0,64	0,63	1,77	2,60	0,62	1,05	1,85
Fitano	6,87	6,54	1,62	1,63	1,45	0,53	1,30	5,71	2,01	4,30	1,71	0,82	0,77	0,63	0,67	0,53	0,99	2,22	4,56	1,06	1,68	1,97
Somas																						
Alif. Res.	266,46	273,86	138,12	128,01	119,58	51,99	78,81	136,52	68,49	121,44	98,12	68,88	45,97	35,04	95,94	90,92	96,57	93,93	97,39	105,20	143,54	106,44
Alif. Tot.	721,60	1162,01	450,95	373,63	346,13	145,49	322,34	753,12	407,91	636,92	401,35	222,05	138,03	98,87	256,21	231,17	234,95	219,59	219,56	229,44	303,66	218,94
MCNR	455,14	888,15	312,83	245,62	226,55	93,50	243,54	616,60	339,42	515,48	303,23	153,17	92,06	63,83	160,27	140,25	138,38	125,66	122,17	124,24	160,12	112,51

<LD = abaixo do limite de detecção do método.

Tabela 14. Concentrações (em µg.g^{-1}) de hidrocarbonetos alifáticos (HAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Agosto/2013. Alif. Res. = Alifáticos Resolvidos; Alif. Tot. = Alifáticos Totais; MCNR = Mistura Complexa Não Resolvida.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alcanos																						
$n\text{-}C_{10}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	0,88	<LD	<LD	<LD	<LD	<LD	<LD	0,93	<LD	0,43
$n\text{-}C_{11}$	3,72	0,58	0,37	<LD	0,46	0,52	0,18	0,14	0,35	0,30	0,31	0,40	0,36	0,59	0,57	0,19	0,24	0,16	0,44	<LD	0,15	0,22
$n\text{-}C_{12}$	2,05	1,35	0,49	0,53	0,92	1,01	0,55	0,28	0,80	0,34	0,27	0,51	0,46	0,88	1,08	0,56	0,52	0,46	0,67	0,35	0,59	0,28
$n\text{-}C_{13}$	2,56	1,64	0,92	0,94	0,78	0,74	0,62	0,56	0,57	0,73	<LD	0,58	0,62	0,52	0,64	0,63	0,61	0,46	0,53	<LD	0,63	0,45
$n\text{-}C_{14}$	<LD	<LD	<LD	<LD	<LD	0,32	<LD	<LD	<LD	<LD	<LD	<LD	0,46	<LD	<LD	<LD	<LD	<LD	<LD	0,29	<LD	0,39
$n\text{-}C_{15}$	1,92	1,45	0,92	0,76	0,78	1,06	0,62	0,67	0,99	0,69	0,75	0,66	0,88	0,96	0,57	0,81	0,49	0,44	0,67	0,84	0,45	0,95
$n\text{-}C_{16}$	3,85	2,31	1,35	1,53	1,28	1,51	1,03	1,16	1,15	1,16	1,12	0,95	1,47	1,03	0,57	0,89	0,73	0,93	1,09	0,81	0,48	1,97
$n\text{-}C_{17}$	6,15	5,11	4,72	1<LD	7,74	4,67	8,24	11,05	8,65	6,90	10,19	9,56	7,99	5,65	0,84	6,22	1,10	2,31	2,96	2,22	0,56	4,13
$n\text{-}C_{18}$	6,15	4,05	2,45	3,71	3,62	2,10	3,22	5,17	2,23	6,25	2,66	3,10	2,81	1,83	0,81	1,59	1,10	1,71	1,23	1,74	1,15	4,84
$n\text{-}C_{19}$	3,21	2,02	3,06	6,00	3,99	1,68	3,73	8,86	3,37	8,82	4,02	5,51	3,29	2,09	0,34	2,59	0,46	1,82	1,32	1,19	0,85	2,83
$n\text{-}C_{20}$	1,41	0,77	<LD	0,65	0,32	<LD	0,33	2,04	0,54	2,14	0,41	0,69	0,72	0,34	<LD	0,19	<LD	<LD	<LD	0,19	0,45	0,71
$n\text{-}C_{21}$	1,28	0,67	0,25	0,65	0,32	0,17	0,29	1,20	0,22	1,41	0,34	0,51	0,33	0,18	<LD	0,26	<LD	0,14	0,15	0,16	0,22	0,43
$n\text{-}C_{22}$	1,15	0,58	0,25	0,47	0,27	0,12	0,26	1,37	0,41	1,37	0,31	0,44	0,36	0,28	0,13	0,22	<LD	<LD	0,12	0,13	0,22	0,45
$n\text{-}C_{23}$	0,51	0,48	0,25	0,24	0,27	0,32	0,15	0,28	0,22	0,30	0,24	0,15	0,20	0,21	<LD	0,19	<LD	0,14	0,15	<LD	0,15	0,22
$n\text{-}C_{24}$	0,64	0,67	<LD	0,29	0,18	0,20	<LD	0,39	0,13	0,47	0,24	0,29	0,26	0,15	0,13	0,15	<LD	0,16	0,15	<LD	0,15	0,26
$n\text{-}C_{25}$	0,90	1,35	0,49	0,53	0,50	0,96	0,29	0,42	0,60	0,30	0,58	0,29	0,55	0,54	0,24	0,41	0,24	0,38	0,47	0,19	0,26	0,48
$n\text{-}C_{26}$	0,77	1,64	0,49	0,29	0,32	0,30	<LD	0,18	0,19	<LD	0,31	0,22	0,26	0,18	0,17	<LD	0,12	0,22	0,29	0,23	0,19	0,35
$n\text{-}C_{27}$	0,64	3,47	0,49	0,47	0,60	1,58	0,37	0,49	1,05	0,17	0,85	0,22	0,98	0,75	0,27	0,52	0,18	0,46	0,70	0,16	<LD	0,48
$n\text{-}C_{28}$	<LD	5,79	<LD	<LD	<LD	0,35	<LD	<LD	0,16	<LD	<LD	<LD	0,16	0,10	<LD	<LD	<LD	0,11	0,18	<LD	<LD	0,11
$n\text{-}C_{29}$	0,77	11,86	0,74	0,76	0,96	2,82	0,81	0,84	2,16	0,39	1,70	0,44	1,60	1,32	0,37	0,89	0,28	0,63	1,29	0,23	<LD	0,65
$n\text{-}C_{30}$	<LD	15,14	<LD	<LD	<LD	0,22	<LD	0,14	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{31}$	0,51	19,09	0,31	0,24	0,41	1,09	0,33	0,46	0,83	0,17	0,82	0,18	0,42	0,49	0,17	<LD	0,12	0,16	0,53	0,13	<LD	0,30
$n\text{-}C_{32}$	<LD	16,58	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$n\text{-}C_{33}$	<LD	<LD	0,55	0,47	0,37	0,62	0,33	0,39	0,54	0,34	0,48	0,29	<LD	0,31	0,27	0,26	0,21	0,24	0,47	0,32	<LD	0,28

n-C$_{34}$	<LD	6,94	0,74	<LD	<LD	0,27	<LD	0,46	0,35	<LD	<LD	<LD	<LD	0,28	0,37	<LD	0,37	0,30	0,38	0,39	<LD	0,26
n-C$_{35}$	<LD	3,47	<LD	<LD	<LD	0,42	<LD	<LD	0,51	<LD	<LD	<LD	<LD	0,41	0,50	<LD	0,49	0,38	0,50	0,52	<LD	0,39
n-C$_{36}$	<LD	2,02	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{37}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{38}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{39}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{40}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Pristano	3,97	2,51	1,35	1,35	1,83	1,21	1,54	1,72	0,99	2,01	1,64	1,31	1,57	0,93	0,71	1,15	0,80	0,90	1,06	1,45	0,52	2,49
Fitano	2,82	2,02	1,04	1,76	1,60	0,84	1,57	2,78	1,05	3,56	1,30	1,68	1,44	0,90	0,40	0,81	0,49	0,71	0,50	0,81	0,59	1,95
Somas																						
Alif. Res.	237,96	264,47	118,21	120,59	77,80	65,43	61,27	81,84	70,52	114,07	96,49	74,99	91,18	62,31	66,77	71,31	55,36	53,20	55,73	72,70	74,36	72,16
Alif. Tot.	557,04	489,95	184,48	329,47	175,75	107,72	189,27	448,25	208,86	511,73	238,47	249,33	252,37	157,30	94,52	146,89	79,79	105,53	103,54	138,20	140,73	240,66
MCNR	319,08	225,49	66,26	208,88	97,94	42,29	128,01	366,41	138,34	397,66	141,98	174,34	161,19	94,99	27,75	75,58	24,44	52,33	47,82	65,50	66,37	168,50

<LD = abaixo do limite de detecção do método.

Tabela 15. Concentrações (em µg.g^{-1}) de hidrocarbonetos alifáticos (HAs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Março/2014. Alif. Res. = Alifáticos Resolvidos; Alif. Tot. = Alifáticos Totais; MCNR = Mistura Complexa Não Resolvida.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Alcanos																						
n-C$_{10}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	0,26	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{11}$	<LD	0,21	na	2,23	0,20	0,44	0,53	0,41	na	<LD	0,26	0,47	1,01	0,21	<LD	0,11	0,54	0,45	<LD	0,29	0,17	0,14
n-C$_{12}$	1,20	0,55	na	3,34	0,56	0,76	0,79	0,84	na	0,19	0,57	1,04	1,48	0,41	0,35	0,40	0,80	0,80	0,21	0,59	0,44	0,29
n-C$_{13}$	1,60	0,76	na	1,51	0,68	0,52	0,39	0,56	na	0,23	0,34	0,57	0,54	0,23	0,58	0,34	0,36	0,41	0,22	0,30	0,28	0,19
n-C$_{14}$	<LD	<LD	na	0,56	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	0,15	0,10	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{15}$	4,20	3,07	na	6,20	3,71	2,74	2,53	3,46	na	1,10	1,45	1,93	2,80	1,10	1,03	1,39	0,88	0,92	0,83	0,92	1,15	0,80
n-C$_{16}$	3,80	2,73	na	2,47	2,55	0,60	0,70	0,44	na	0,36	0,30	0,41	0,62	0,31	0,51	0,29	0,20	0,27	0,21	0,15	0,16	0,18
n-C$_{17}$	6,90	3,53	na	4,45	6,15	1,62	2,57	2,15	na	0,95	0,66	0,82	0,94	0,74	1,38	0,86	0,68	0,78	0,87	0,20	0,53	0,64
n-C$_{18}$	2,80	1,18	na	1,35	16,20	1,07	5,45	4,02	na	0,53	0,26	0,38	0,49	0,42	5,30	1,20	1,78	2,75	1,08	0,06	0,98	1,35
n-C$_{19}$	1,70	1,05	na	1,11	24,90	1,04	7,43	7,67	na	0,42	0,19	0,32	0,37	0,38	15,17	1,85	3,97	6,00	1,38	<LD	1,89	2,69
n-C$_{20}$	0,50	0,46	na	1,19	11,53	0,26	3,83	5,18	na	0,10	<LD	0,13	0,32	0,12	8,93	0,90	2,95	3,82	0,53	<LD	1,16	1,67
n-C$_{21}$	0,80	0,50	na	0,48	6,51	0,31	3,03	3,65	na	0,14	0,11	0,13	0,15	0,16	6,59	0,67	3,42	3,58	0,33	<LD	0,68	1,50
n-C$_{22}$	0,60	0,34	na	0,48	7,98	0,26	3,17	3,56	na	0,13	0,09	0,13	0,17	0,13	5,50	0,74	2,37	2,49	0,38	<LD	0,72	1,34
n-C$_{23}$	0,70	0,38	na	0,48	1,08	0,50	0,61	0,87	na	0,19	0,23	0,13	0,25	0,22	1,19	0,31	0,75	0,66	0,11	<LD	0,09	0,36
n-C$_{24}$	0,50	<LD	na	0,48	0,48	0,16	0,64	0,87	na	0,09	0,09	<LD	0,22	0,10	1,22	0,23	0,92	0,66	0,18	<LD	0,10	0,34
n-C$_{25}$	1,00	0,59	na	0,80	1,08	1,31	0,90	0,75	na	0,43	0,45	0,22	0,57	0,53	0,26	0,48	0,42	0,31	0,22	<LD	0,11	0,22
n-C$_{26}$	0,40	0,25	na	0,56	0,20	0,29	0,22	0,41	na	0,10	0,09	<LD	0,32	0,14	0,16	0,13	<LD	0,12	0,08	0,06	<LD	0,04
n-C$_{27}$	1,30	0,88	na	1,19	0,68	2,35	1,47	1,00	na	0,61	0,70	0,28	1,46	0,87	0,13	0,95	0,31	0,45	0,30	<LD	<LD	0,22
n-C$_{28}$	0,40	0,17	na	<LD	0,16	0,47	0,35	0,37	na	0,09	0,09	<LD	0,37	0,18	<LD	0,19	<LD	0,08	<LD	<LD	<LD	0,04
n-C$_{29}$	2,70	3,32	na	2,39	1,44	4,15	3,39	1,78	na	1,07	1,15	0,63	3,29	1,43	0,64	1,85	0,47	0,80	0,54	0,12	<LD	0,43
n-C$_{30}$	<LD	0,34	na	<LD	<LD	0,29	0,26	0,25	na	0,06	<LD	<LD	0,20	0,10	<LD	0,10	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{31}$	2,80	4,92	na	1,43	0,96	1,36	1,76	0,87	na	0,49	0,43	0,22	0,96	0,51	0,29	0,52	0,19	0,27	0,20	<LD	<LD	0,21
n-C$_{32}$	<LD	0,29	na	<LD	<LD	0,10	0,15	0,16	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{33}$	1,90	1,55	na	1,11	0,64	0,78	0,99	0,56	na	0,30	0,25	0,25	0,54	0,27	0,29	0,38	0,17	0,25	0,17	<LD	0,07	0,15

CV

n-C$_{34}$	1,20	<LD	na	<LD	0,52	0,31	0,26	0,44	na	0,17	0,25	<LD	0,30	0,12	<LD	0,25	0,20	0,25	<LD	<LD	<LD	0,13
n-C$_{35}$	1,60	<LD	na	<LD	0,64	0,50	0,39	0,53	na	0,25	0,30	<LD	<LD	0,20	<LD	0,36	0,25	0,31	0,21	<LD	<LD	0,17
n-C$_{36}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{37}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{38}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{39}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
n-C$_{40}$	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
Pristano	2,40	2,10	na	2,47	2,99	1,28	2,05	1,03	na	0,71	0,42	0,44	0,69	0,41	0,77	0,59	0,41	0,64	0,47	0,15	0,35	0,38
Fitano	2,00	0,84	na	0,95	6,90	0,73	3,10	1,97	na	0,39	0,23	0,35	0,40	0,30	3,09	0,67	0,90	1,38	0,59	0,09	0,54	0,64
Somas																						
Alif. Res.	242,07	102,64	na	188,40	132,30	75,98	90,20	96,83	na	34,86	39,30	69,62	68,49	27,78	103,26	50,07	54,22	67,51	39,03	37,04	30,77	32,25
Alif. Tot.	249,47	228,73	na	188,40	1591,43	195,12	592,05	611,01	na	77,39	39,30	101,64	137,61	82,55	1064,82	182,38	395,76	453,64	137,33	62,24	171,23	241,96
MCNR	7,40	126,09	na	<LD	1459,13	119,14	501,86	514,18	na	42,53	<LD	32,02	69,12	54,77	961,56	132,30	341,53	386,13	98,30	25,20	140,46	209,71

<LD = abaixo do limite de detecção do método.
na = não analisada
Obs. 1: a amostra 3 não pode ser analisada.
Obs. 2: a amostra 9 não pode ser coletada.

Tabela 16. Concentrações (em ng.L^{-1}) de alquilbenzenos lineares (LABs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Abril/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LABs																						
5-C_{10}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C_{10}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C_{10}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C_{10}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C_{11}-LAB	1,78	2,31	<LD	<LD	1,52	1,56	2,50	<LD	2,51	<LD	1,95	2,57	2,26	2,07	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C_{11}-LAB	1,56	1,89	<LD	<LD	<LD	<LD	1,80	<LD	2,55	<LD	2,11	2,07	2,05	2,47	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C_{11}-LAB	<LD	2,03	<LD	<LD	<LD	<LD	1,68	<LD	3,33	<LD	2,50	2,27	2,16	2,84	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C_{11}-LAB	<LD	1,44	<LD	<LD	<LD	<LD	<LD	<LD	2,04	<LD	1,89	1,72	1,64	2,10	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C_{11}-LAB	<LD	1,73	<LD	<LD	1,50	1,50	<LD	<LD	3,27	1,71	2,11	<LD	1,86	2,47	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C_{12}-LAB	4,54	4,35	2,08	2,46	2,60	1,66	3,12	2,01	4,76	3,08	4,00	3,96	3,43	3,74	1,63	<LD	1,50	1,77	2,01	<LD	1,83	1,74
5-C_{12}-LAB	2,61	3,56	1,41	1,55	1,46	1,56	2,33	1,52	3,93	1,92	2,97	2,64	2,42	2,76	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C_{12}-LAB	1,41	2,92	<LD	1,42	<LD	<LD	<LD	<LD	3,45	2,07	2,09	2,65	2,19	2,58	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C_{12}-LAB	<LD	2,04	<LD	<LD	<LD	<LD	<LD	<LD	2,71	<LD	1,76	1,94	<LD	1,47	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C_{12}-LAB	1,47	1,61	<LD	<LD	<LD	<LD	<LD	<LD	2,98	2,00	1,89	<LD	<LD	1,98	<LD	<LD	<LD	1,41	<LD	<LD	<LD	1,49
(7+6)-C_{13}-LAB	6,13	8,23	3,23	4,27	4,69	3,89	3,82	3,80	8,25	5,11	5,24	5,67	4,92	5,31	1,85	2,02	3,30	3,02	2,94	2,35	3,38	4,00
5-C_{13}-LAB	3,89	6,64	1,77	2,75	2,64	2,17	3,19	3,14	6,02	3,48	4,52	4,16	3,11	3,91	<LD	1,54	1,89	2,52	2,57	1,50	2,31	2,43
4-C_{13}-LAB	2,64	3,61	1,55	1,65	1,50	1,04	2,38	1,95	4,43	2,30	2,24	2,53	2,57	1,94	<LD	<LD	1,72	2,09	2,02	<LD	1,97	2,07
3-C_{13}-LAB	1,81	2,30	0,91	1,20	1,11	0,80	1,68	1,76	3,14	1,78	2,78	6,93	1,70	2,01	1,69	<LD	<LD	2,51	2,82	<LD	2,27	2,17
2-C_{13}-LAB	1,86	2,55	2,54	2,50	1,92	1,35	1,42	2,44	5,52	4,30	3,10	3,02	2,90	2,78	1,50	1,90	3,42	3,01	3,91	3,23	4,41	3,51
7-C_{14}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C_{14}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C_{14}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C_{14}-LAB	<LD	1,86	<LD	<LD	<LD	<LD	<LD	<LD	1,80	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C_{14}-LAB	<LD	1,66	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C_{14}-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método (1,4 ng.L^{-1}).

Tabela 17. Concentrações (em ng.L^{-1}) de alquilbenzenos lineares (LABs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Agosto/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LABs																						
5-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,52	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{11}$-LAB	<LD	<LD	<LD	<LD	<LD	2,17	<LD	<LD	<LD	<LD	<LD	<LD	2,70	<LD	<LD	<LD	<LD	2,54	2,28	<LD	<LD	1,71
5-C$_{11}$-LAB	<LD	<LD	<LD	<LD	<LD	2,60	<LD	<LD	1,50	<LD	<LD	<LD	2,23	<LD	<LD	<LD	<LD	2,76	3,43	<LD	<LD	1,49
4-C$_{11}$-LAB	1,59	<LD	<LD	<LD	<LD	2,93	<LD	<LD	1,45	<LD	<LD	<LD	2,07	1,56	<LD	<LD	<LD	2,75	2,99	<LD	<LD	2,42
3-C$_{11}$-LAB	<LD	<LD	<LD	<LD	<LD	2,11	<LD	<LD	<LD	<LD	<LD	<LD	1,67	<LD	<LD	<LD	<LD	2,12	2,31	<LD	<LD	<LD
2-C$_{11}$-LAB	1,87	<LD	<LD	<LD	2,07	3,53	1,67	2,71	1,56	1,70	<LD	<LD	3,72	<LD	1,48	<LD	<LD	2,58	2,75	<LD	<LD	2,09
6-C$_{12}$-LAB	3,05	1,91	2,78	1,64	3,35	6,43	3,03	3,96	2,66	3,32	2,15	2,96	4,89	2,95	3,04	2,59	2,13	5,69	5,88	1,59	1,58	4,90
5-C$_{12}$-LAB	2,11	1,44	1,84	<LD	2,69	4,02	2,46	3,28	2,22	2,58	1,56	2,29	4,37	2,24	1,98	1,60	1,63	4,89	4,16	<LD	<LD	3,90
4-C$_{12}$-LAB	1,58	1,44	1,45	1,42	2,72	3,30	2,19	3,14	2,11	1,94	<LD	2,46	3,22	2,31	1,91	1,41	<LD	4,57	3,24	<LD	<LD	4,40
3-C$_{12}$-LAB	<LD	<LD	<LD	<LD	2,01	2,39	1,60	2,10	<LD	1,87	<LD	<LD	3,67	<LD	<LD	<LD	<LD	2,55	1,94	<LD	<LD	2,96
2-C$_{12}$-LAB	1,51	1,46	<LD	<LD	3,10	3,49	2,44	2,81	1,70	2,43	1,55	1,63	2,51	1,67	1,42	<LD	<LD	2,36	2,02	<LD	<LD	2,33
(7+6)-C$_{13}$-LAB	5,41	4,10	3,45	3,90	8,18	10,30	7,86	7,98	5,18	8,67	5,11	8,23	10,04	5,85	4,53	3,72	3,75	10,04	6,76	3,52	2,88	12,69
5-C$_{13}$-LAB	3,20	2,82	2,35	3,03	5,60	6,76	5,21	4,73	3,24	4,70	3,26	5,00	7,85	4,59	2,61	2,78	2,54	5,63	4,08	2,12	2,57	8,33
4-C$_{13}$-LAB	2,39	2,27	1,92	2,04	4,33	4,86	3,81	3,60	2,47	3,29	2,42	3,02	5,43	3,03	2,09	2,15	1,87	3,88	2,90	1,78	1,42	3,81
3-C$_{13}$-LAB	1,47	1,69	<LD	2,35	3,73	3,45	2,88	2,98	1,78	3,49	2,00	2,97	5,26	2,20	<LD	1,73	1,47	2,64	1,84	1,68	1,59	5,08
2-C$_{13}$-LAB	2,75	2,78	2,26	2,75	5,21	4,44	4,14	5,25	2,31	4,89	2,97	4,74	5,68	3,47	2,03	2,54	1,76	3,69	2,40	3,15	1,76	4,61
7-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método (1,4 ng.L^{-1}).

Tabela 18. Concentrações (em ng.L^{-1}) de alquilbenzenos lineares (LABs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Março/2014.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LABs																						
5-C$_{10}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{10}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{10}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{10}$-LAB	na	1,74	na	1,70	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{11}$-LAB	na	1,52	na	1,41	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{11}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{11}$-LAB	na	2,12	na	1,53	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{11}$-LAB	na	2,05	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{11}$-LAB	na	1,65	na	1,70	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{12}$-LAB	na	<LD	na	1,58	2,05	1,47	1,97	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{12}$-LAB	na	1,90	na	<LD	1,74	<LD	1,59	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{12}$-LAB	na	<LD	na	<LD	1,46	<LD	1,56	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{12}$-LAB	na	<LD	na	<LD	1,43	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{12}$-LAB	na	<LD	na	1,46	2,50	<LD	1,66	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
(7+6)-C$_{13}$-LAB	na	2,10	na	<LD	6,51	2,47	5,59	2,54	na	2,46	1,42	<LD	<LD	<LD	3,00	<LD	1,52	1,62	0,79	0,39	1,40	1,64
5-C$_{13}$-LAB	na	1,84	na	<LD	4,24	1,99	4,75	1,69	na	<LD	<LD	<LD	<LD	<LD	2,42	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{13}$-LAB	na	1,59	na	<LD	4,01	1,80	3,71	1,72	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{13}$-LAB	na	3,67	na	3,90	4,00	<LD	3,52	1,57	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{13}$-LAB	na	<LD	na	1,76	6,60	<LD	4,55	3,13	na	<LD	<LD	<LD	2,32	<LD	7,56	1,42	3,54	2,89	<LD	<LD	1,88	3,13
7-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{14}$-LAB	na	<LD	na	<LD	1,55	<LD	1,56	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{14}$-LAB	na	1,43	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	2,30	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	1,98	<LD	<LD	<LD	<LD	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método (1,4 ng.L^{-1}).
na = não analisada.
Obs. 1: a amostra 1 foi descartada devido à má recuperação.
Obs. 2: a amostra 3 não pode ser analisada.
Obs. 3: a amostra 9 não pode ser coletada.

Tabela 19. Concentrações (em ng.g^{-1}) de alquilbenzenos lineares (LABs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Abril/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LABs																						
5-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{10}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{11}$-LAB	149,04	171,66	<LD	<LD	58,02	24,84	79,47	<LD	29,39	<LD	48,34	78,15	41,31	26,23	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{11}$-LAB	130,62	140,45	<LD	<LD	<LD	<LD	57,22	<LD	29,86	<LD	52,30	62,95	37,47	31,30	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{11}$-LAB	<LD	150,85	<LD	<LD	<LD	<LD	53,41	<LD	38,99	<LD	61,97	69,03	39,48	35,99	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{11}$-LAB	<LD	107,01	<LD	<LD	<LD	<LD	<LD	<LD	23,89	<LD	46,85	52,30	29,97	26,61	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{11}$-LAB	<LD	128,56	<LD	<LD	57,25	23,89	<LD	<LD	38,29	51,42	52,30	<LD	33,99	31,30	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{12}$-LAB	380,14	323,25	129,31	114,80	99,24	26,43	99,18	78,08	55,74	92,61	99,15	120,42	62,69	47,39	51,86	<LD	41,21	44,16	48,75	<LD	58,17	38,86
5-C$_{12}$-LAB	218,54	264,54	87,66	72,33	55,73	24,84	74,07	59,05	46,02	57,73	73,62	80,28	44,23	34,97	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{12}$-LAB	118,06	216,99	<LD	66,27	<LD	<LD	<LD	<LD	40,40	62,24	51,81	80,58	40,03	32,69	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{12}$-LAB	<LD	151,59	<LD	<LD	<LD	<LD	<LD	<LD	31,73	<LD	43,63	58,99	<LD	18,63	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{12}$-LAB	123,09	119,64	<LD	<LD	<LD	<LD	<LD	<LD	34,89	60,14	46,85	<LD	<LD	25,09	<LD	<LD	<LD	35,17	<LD	<LD	<LD	33,28
(7+6)-C$_{13}$-LAB	513,28	611,57	200,80	199,27	179,01	61,94	121,44	147,61	96,60	153,65	129,89	172,42	89,92	67,29	58,86	56,25	90,66	75,34	71,31	57,96	107,45	89,34
5-C$_{13}$-LAB	325,72	493,42	110,04	128,33	100,76	34,55	101,41	121,98	70,49	104,64	112,04	126,50	56,84	49,55	<LD	42,88	51,92	62,87	62,34	37,00	73,43	54,28
4-C$_{13}$-LAB	221,05	268,26	96,36	77,00	57,25	16,56	75,66	75,75	51,87	69,16	55,52	76,93	46,97	24,58	<LD	<LD	47,25	52,14	49,00	<LD	62,62	46,23
3-C$_{13}$-LAB	151,56	170,91	56,57	56,00	42,37	12,74	53,41	68,37	36,77	53,52	68,91	210,73	31,07	25,47	53,77	<LD	<LD	62,62	68,40	<LD	72,16	48,47
2-C$_{13}$-LAB	155,74	189,49	157,90	116,67	73,28	21,50	45,14	94,78	64,64	129,30	76,84	91,83	53,00	35,23	47,73	52,90	93,96	75,09	94,84	79,67	140,19	78,40
7-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{14}$-LAB	<LD	138,22	<LD	<LD	<LD	<LD	<LD	<LD	21,08	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{14}$-LAB	<LD	123,35	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{14}$-LAB	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método.

Tabela 20. Concentrações (em ng.g^{-1}) de alquilbenzenos lineares (LABs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Agosto/2013.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LABs																						
$5\text{-}C_{10}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$4\text{-}C_{10}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$3\text{-}C_{10}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$2\text{-}C_{10}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	49,58	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$6\text{-}C_{11}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	53,60	<LD	<LD	<LD	<LD	<LD	<LD	88,07	<LD	<LD	<LD	<LD	69,13	66,89	<LD	<LD	36,97
$5\text{-}C_{11}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	64,22	<LD	<LD	47,73	<LD	<LD	<LD	72,74	<LD	<LD	<LD	<LD	75,12	100,63	<LD	<LD	32,21
$4\text{-}C_{11}\text{-LAB}$	203,85	<LD	<LD	<LD	<LD	72,37	<LD	<LD	46,14	<LD	<LD	<LD	67,52	40,27	<LD	<LD	<LD	74,84	87,72	<LD	<LD	52,32
$3\text{-}C_{11}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	52,12	<LD	<LD	<LD	<LD	<LD	<LD	54,47	<LD	<LD	<LD	<LD	57,70	67,77	<LD	<LD	<LD
$2\text{-}C_{11}\text{-LAB}$	239,74	<LD	<LD	<LD	94,83	87,19	61,14	95,33	49,64	72,83	<LD	<LD	121,34	<LD	49,81	<LD	<LD	70,22	80,68	<LD	<LD	45,18
$6\text{-}C_{12}\text{-LAB}$	391,03	184,16	170,40	96,47	153,47	158,82	110,93	139,30	84,64	142,23	73,27	108,03	159,51	76,14	102,31	95,93	65,22	154,86	172,51	51,24	58,64	105,93
$5\text{-}C_{12}\text{-LAB}$	270,51	138,84	112,78	<LD	123,23	99,29	90,06	115,38	70,64	110,53	53,16	83,58	142,54	57,82	66,63	59,26	49,91	133,09	122,05	<LD	<LD	84,31
$4\text{-}C_{12}\text{-LAB}$	202,56	138,84	88,88	83,53	124,61	81,51	80,18	110,45	67,14	83,11	<LD	89,78	105,03	59,62	64,28	52,22	<LD	124,38	95,05	<LD	<LD	95,12
$3\text{-}C_{12}\text{-LAB}$	<LD	<LD	<LD	<LD	92,08	59,03	58,58	73,87	<LD	80,11	<LD	<LD	119,71	<LD	<LD	<LD	<LD	69,40	56,92	<LD	<LD	63,99
$2\text{-}C_{12}\text{-LAB}$	193,59	140,77	<LD	<LD	142,02	86,20	89,33	98,84	54,09	104,10	52,82	59,49	81,87	43,10	47,79	<LD	<LD	64,23	59,26	<LD	<LD	50,37
$(7+6)\text{-}C_{13}\text{-LAB}$	693,59	395,32	211,47	229,41	374,74	254,41	287,76	280,70	164,82	371,42	174,15	300,36	327,49	151,00	152,45	137,78	114,83	273,25	198,32	113,44	106,89	274,34
$5\text{-}C_{13}\text{-LAB}$	410,26	271,90	144,05	178,24	256,54	166,97	190,74	166,38	103,09	201,35	111,10	182,48	256,06	118,47	87,84	102,96	77,78	153,23	119,70	68,32	95,39	180,08
$4\text{-}C_{13}\text{-LAB}$	306,41	218,87	117,69	12<LD	198,36	120,04	139,49	126,63	78,59	140,94	82,47	110,22	177,12	78,21	70,34	79,63	57,26	105,60	85,08	57,37	52,70	82,37
$3\text{-}C_{13}\text{-LAB}$	188,46	162,95	<LD	138,24	170,88	85,22	105,44	104,82	56,64	149,51	68,16	108,39	171,58	56,78	<LD	64,07	45,01	71,85	53,98	54,14	59,01	109,82
$2\text{-}C_{13}\text{-LAB}$	352,56	268,04	138,53	161,76	238,68	109,67	151,57	184,67	73,50	209,49	101,22	172,99	185,27	89,56	68,32	94,07	53,89	100,43	70,41	101,52	65,32	99,66
$7\text{-}C_{14}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$6\text{-}C_{14}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$5\text{-}C_{14}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$4\text{-}C_{14}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$3\text{-}C_{14}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
$2\text{-}C_{14}\text{-LAB}$	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método.

Tabela 21. Concentrações (em ng.g^{-1}) de alquilbenzenos lineares (LABs) no material particulado em suspensão da Baía de Guaratuba, Brasil, em Março/2014.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LABs																						
5-C$_{10}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{10}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{10}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{10}$-LAB	na	73,11	na	135,23	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{11}$-LAB	na	63,87	na	112,16	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{11}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{11}$-LAB	na	89,08	na	121,70	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{11}$-LAB	na	86,13	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{11}$-LAB	na	69,33	na	135,23	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{12}$-LAB	na	<LD	na	125,68	81,81	38,40	36,12	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{12}$-LAB	na	79,83	na	<LD	69,44	<LD	29,15	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{12}$-LAB	na	<LD	na	<LD	58,27	<LD	28,60	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{12}$-LAB	na	<LD	na	<LD	57,07	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{12}$-LAB	na	<LD	na	116,14	99,77	<LD	30,43	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
(7+6)-C$_{13}$-LAB	na	88,24	na	<LD	259,81	64,51	102,49	79,23	na	35,49	26,81	<LD	<LD	<LD	96,42	<LD	25,76	33,29	10,38	5,86	19,87	16,02
5-C$_{13}$-LAB	na	77,31	na	<LD	169,21	51,98	87,09	52,72	na	<LD	<LD	<LD	<LD	<LD	77,78	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{13}$-LAB	na	66,81	na	<LD	160,03	47,01	68,02	53,65	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{13}$-LAB	na	154,20	na	310,23	159,64	<LD	64,54	48,98	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{13}$-LAB	na	<LD	na	140,00	263,40	<LD	83,42	97,64	na	<LD	<LD	<LD	57,39	<LD	242,98	27,11	60,00	59,40	<LD	<LD	26,68	30,57
7-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
6-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
5-C$_{14}$-LAB	na	<LD	na	<LD	61,86	<LD	28,60	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
4-C$_{14}$-LAB	na	60,08	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
3-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	42,17	<LD	na	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD	<LD
2-C$_{14}$-LAB	na	<LD	na	<LD	<LD	<LD	<LD	<LD	na	<LD	<LD	<LD	<LD	<LD	63,64	<LD	<LD	<LD	<LD	<LD	<LD	<LD

<LD = abaixo do limite de detecção do método.
na = não analisada.
Obs. 1: a amostra 1 foi descartada devido à má recuperação.
Obs. 2: a amostra 3 não pode ser analisada.
Obs. 3: a amostra 9 não pode ser coletada.