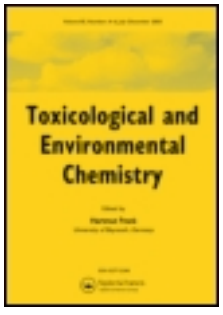

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Inorganic and organic contaminants in sediments from an urban playa and associated toxicity among Hyalella azteca

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Inorganic and organic contaminants in sediments from an urban playa and associated toxicity among *Hyalella azteca*

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Playa wetlands are important components of the Southern High Plains (USA) landscape as they are the major aquatic surface feature. Chemical contaminants associated with playas have been documented, particularly for grassland and agricultural watersheds, but not for playas in urban settings. The objectives of this study were to determine concentrations of inorganic and organic contaminants in sediments from an urban playa within the I-20 Wildlife Preserve and Jenna Welch Nature Study Center in Midland, TX, and evaluate toxicity of these sediments to *Hyalella azteca*. Concentrations of most trace elements were below sediment quality guidelines with exceptions of lead, cadmium, and arsenic. Concentrations of organic contaminants, particularly PAHs, DDT, DDE, and malathion, were above sediment quality guidelines at various locations within the playa. Decreased survival was observed among *H. azteca* exposed to sediment from a single location when compared those exposed to reference sediments. This location also produced maximum observed concentrations for five of seven trace elements, potentially due to its location at the lowest elevation within the playa. This study documented concentrations of contaminants in sediments of an urban playa associated with past and present land uses in its urban setting, including those from automotive emissions and historical pesticide use.

Keywords: playa wetlands; sediments; toxicity; trace metals; urban; *Hyalella azteca*

Introduction

Playa wetlands occupy approximately 2% of surface area in the Southern High Plains (SHP) and are the predominant native aquatic habitat, with more than 21,000 playas occurring across nearly nine million hectares (Haukos and Smith 1994). Playas are classified as shallow, circular, ephemerally moist basins found in plains and desert landscapes (Bolen, Smith, and Schramm 1989; Sabin and Holliday 1995). Playa wetlands are important ecosystem components in the SHP of Texas, representing the primary surface water feature (Sabin and Holliday 1995).

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Playas provide habitat for wetland-dependent species in the SHP and are essential in maintaining regional biodiversity (Tsai et al. 2007; Smith et al. 2011). Other functions of playas include: nutrient cycling, water storage, and removal, sequestration or conversion of elements, compounds, and particulates (Smith 2003). Playas also serve as the principal collection basins for surface drainage in the SHP. Depending on the amount of precipitation, unmodified playas are typically dry during late winter and early spring and wet from late spring to fall (Bolen, Smith, and Schramm 1989). Additionally, land use in playa watersheds affects hydrology and hydroperiod, while specific factors such as soil porosity, vegetative cover, and cultivation affect surface runoff and soil water storage capacity (Tsai et al. 2007). Surface runoff can transport a variety of contaminants into playas depending on land use within each individual watershed (Arefeen 1995; Wolf 1996; Fish et al. 1999).

Although there are approximately only 500 playas currently impacted by urban development, urban expansion has been identified as one of the many threats to playa integrity in the SHP due to changes to playa structure and function (Haukos 2007; Smith et al. 2011). Urban playas are much different from rural playas because they are often used for storm water management, and may be modified to increase water volume and thus, continuously inundated for years (Arefeen 1995; Haukos and Smith 2003; Smith 2003; Haukos 2007). Surfaces that drain into urban watersheds may include large areas of impervious materials, including buildings, roads, sidewalks, and parking lots, which result in increased runoff volume into urban aquatic systems compared to those in undisturbed watersheds (Porcella and Sorensen 1980). Urban playas may serve as catchments for point source industrial contaminants, as well as non-point contaminants such as nutrients and pesticides from lawn and garden chemical applications as well as trace elements from vehicle emissions (Porcella and Sorensen 1980; Irwin et al. 1996), which are less frequently detected in playas occurring in rural areas.

Few studies have characterized and quantified chemical contaminants in rural playa water, sediments, or associated wildlife. Among the published studies examining playa contaminants, the primary focus has been on playa watersheds within agricultural and grassland (i.e. rural) settings (Wallace 1984; Flickinger and Krynitsky 1987; Irwin et al. 1996; Venne et al. 2006, 2008; Belden et al. 2012). To our knowledge, two studies have reported trace element concentrations in water and sediments of urban playas (Huang 1992; Arefeen 1995). No published studies, however, have evaluated concentrations of both inorganic and organic contaminants and their effects in sediments of urban playas, despite increased potential for anthropogenic impacts in an urban setting.

Sediments are a known repository for many persistent, anthropogenic inorganic, and organic contaminants that are toxic to benthic organisms, such as *Hyalella azteca*. *H. azteca* (order: Amphipoda) is a freshwater crustacean and an epibenthic detritivore. *H. azteca* occurs in wetlands, lakes, and rivers throughout North America and is closely associated with surficial sediments (de March 1981). Sediment toxicity tests using field-collected sediment samples reflect cumulative and interactive effects of complex mixtures of contaminants (Rand 1995). Therefore, the objectives of this study were to quantify inorganic and organic contaminant concentrations and assess potential toxicity to *H. azteca* of sediments from an urban playa in the I-20 Wildlife Preserve and Jenna Welch Nature Study Center located in Midland, Texas.

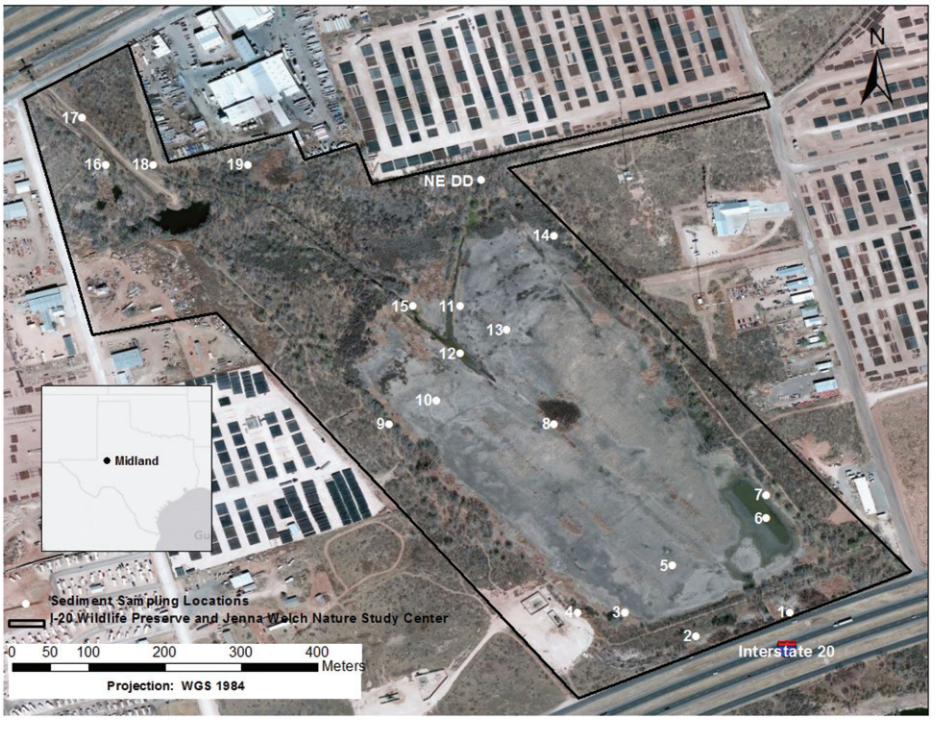

Figure 1. Map of the I-20 Wildlife Preserve and Jenna Welch Nature Study Center, Midland, Texas, identifying sediment sampling locations within the urban playa. Aerial photograph provided courtesy of Bing Maps and ESRI Press.

Materials and methods

Study site and sample collection

The study site was a publically owned urban playa wetland contained within the 36-hectare I-20 Wildlife Preserve and Jenna Welch Nature Study Center in Midland, Texas located between US Interstate 20 and Industrial Avenue on the southwest edge of Midland. The wetland itself is approximately 12 hectares, with its bed sediment classified as the hydric soil Lipan Clay (Lp) series (USDA 2006). Two drainage inputs enter the site from the northwest and northeast. There is one outflow and an overflow spillway at the southernmost end of the site. Surface runoff drains into the wetland from immediately adjacent industrial areas to the north, east, and west and residential areas approximately 0.5 km to the north. Other site features include three small constructed ponds (formerly quarry pits and a cattle pond), forested area in the floodplain, upland scrub communities, and grasslands (Ducks Unlimited 2010; Figure 1).

Sediment cores from 19 locations within the study site were collected on May 13 and 14, 2009 (Figure 1). At the time of collection, the playa was dry and the bed cracked with moist, but not wet, subsurface sediments. Cores were collected to classify sediment characteristics, determine sediment accumulation and depth, determine depth of the clay layer, and quantify trace elements (Ducks Unlimited 2010). Cores were sectioned

from 0–30.5 and 30.5–61 cm up to 61 cm and then according to horizon at greater depths. Samples were transported to Texas Tech University and stored in plastic Ziploc® bags at 4°C until analysis.

Additional sediment cores were collected on February 11, 2011 from locations 1, 6, 12, 16, and one additional location in the northeast drainage ditch (NE DD) to evaluate organic contaminant concentrations and for toxicity testing. Sediment cores were sectioned from 0 to 30.5 and 30.5 to 61 cm, with the exception of location 17, where 0–30.5 and 30.5–45.7 cm core sections were collected due to soil compaction. These locations were selected for the following reasons: Location 1 was situated at the outlet of the playa; Location 6 produced sediments with the highest concentrations of five of seven elements in 2009; Location 12 yielded sediment with the maximum observed concentration of cadmium and was located where two inputs enter the playa; Location 16 was located in a caliche pit that had different sediment and basin characteristics than the rest of the playa; Location 17 and NE DD were located in two inputs of the playa, which allowed for monitoring of nonpoint sources from these inputs. Sediments collected at most locations, with the exception of NE DD and Location 17, were saturated with water. Reference sediment for toxicity testing was collected from 0 to 38.1 cm on April 13, 2011 from a grassland playa wetland in Ector County, Texas and had a watershed with minimal anthropogenic disturbances. This playa's bed sediment was also classified as the hydric soil Lipan Clay (Lp) series (USDA 2006). Samples collected on February 11 and April 13, 2011 were transported to Texas Tech University and stored in glass jars and plastic Ziploc® bags, respectively, at −80°C until analysis to ensure sample integrity.

Inorganic analyses

The method used for the digestion of sediment samples prior to trace element analysis was a slight variation of USEPA SW-846 Method 3050B (USEPA 1996; Cobb et al. 2006). Concentrations of aluminum (Al), arsenic (As), chromium (Cr), iron (Fe), cadmium (Cd), and lead (Pb) in digestates were determined using a Perkin Elmer SCIEX ELAN DRC-e Axial Field Technology Inductively Coupled Plasma-Mass Spectrometer with ELAN V. 3.4 Software.

Total mercury (Hg) was determined following a separate acid digestion procedure. Briefly, 1 ± 0.01 g wet weight of each sample was weighed into a 50-mL polypropylene centrifuge tube. Following the addition of 8 mL of trace metal grade concentrated nitric acid (Fisher Scientific), tubes were placed in a 90 ± 5°C hot water bath for 2 h. Digestates were cooled, filtered through Fisher Scientific P2 filter paper, and diluted to 50 mL volume with 18 MΩ water. Mercury concentrations were determined using a CETAC Quick Trace M-8000 Mercury Analyzer with an ASX-520 Autosampler using cold vapor atomic fluorescence spectroscopy and QuickTrace software.

Method blanks (18 MΩ water), calibration blanks, check standards, sample duplicates, and instrument duplicates were performed for QA/QC purposes. NIST Standard Reference Material 1633b Trace Elements in Coal Fly Ash ($0.1431\ mg\ kg^{-1}$ Hg, Canadian National Research Council) and 0.25 g (± 0.01) of the NIST Standard Reference Material 2587 Trace Elements in Soil Containing Lead from Paint ($3000\ mg\ kg^{-1}$ Pb, Canadian National Research Council) were digested in a similar manner as each set of 25 samples to determine method recoveries for mercury and trace metal analyses, respectively. Concentrations were determined on a dry mass basis by drying a separate aliquot of each sediment core to constant mass (± 0.01 g) at 100°C.

Organic analysis

Analytes were extracted into acetonitrile using a modified Quick Easy Cheap Effective Rugged Safe (QuEChERS) method (Zhao and Zhai 2010). A 10 ± 0.1 g ambient air dried sample of each sediment (2009 and 2011) from locations 1, 6, 12, 16, 17, and northeast drainage ditch (NE DD) was extracted in 10 mL of 18 MΩ water and 10 mL spectroscopy grade acetonitrile (Fisher Scientific) spiked at $0.4\,\mu g\,g^{-1}$ tetrachloro-m-xylene (TCMX) and decachlorobiphenyl (DCBP) in a 50-mL centrifuge tube. TCMX and DCBP were used as internal standards to determine method recoveries. Only 6.9 g and 9.2 g of sample were used for the 2009 location 17 (15–30.5 and 30.5–46 cm cores, respectively) due to limited sample. Samples were extracted for 15 h on a shaker plate at 250 rpm (VWR Orbital Shaker), and tubes were centrifuged for 30 min at 3160 rpm in a Beckman Allegra 6R Centrifuge. The acetonitrile phase was then transferred to a 15-mL SampliQ QuEChERS Dispersive SPE tube (UCT) and agitated on a shaker plate for 1 h. Tubes were centrifuged for 30 min at 3160 rpm. Extracts were filtered through a 0.45 μm PTFE syringe filter before analysis. Extracts were analyzed for 13 polycyclic aromatic hydrocarbons (PAHs), 14 ortho-chlorinated polychlorinated biphenyl congeners (IUPAC PCB Congeners 18, 28, 31, 44, 52, 101, 118, 138, 149, 153, 170, 180, 194, 209), 18 organochlorine pesticides (α-benzene hexachloride (BHC), β-BHC, γ-BHC, δ-BHC, heptachlor, heptachlor epoxide, aldrin, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, methoxychlor, *p*,*p*′-DDT, *p*,*p*′-DDE, and p,p′-DDD), and an organophosphate pesticide, malathion. Many of these compounds are persistent in the environment and may be expected in an urban setting. Analyses were performed with a HP 6890 Series Gas Chromatography System with an Agilent DB-5 MS column coupled with a HP 5973 Mass Selective Detector operated in selected ion monitoring (SIM) mode and using Chem Station software.

Sediment toxicity tests

Laboratory cultured *H. azteca* were used to evaluate toxicity associated with sediments by incorporating slight modifications to existing freshwater invertebrate toxicity testing methodology (USEPA 2000). *H. azteca* were used because of their burrowing and feeding behaviors, presence in playa ecosystems, and sensitivity to contaminants often associated with sediments (USEPA 2000; Smith 2003). Exposures consisted of 100 mL of homogenized sediments (locations 1, 6, 12, 16, 17 and NE DD) in 1-L glass jar test chambers with 175 mL of overlying water (reformulated moderately hard water; (USEPA 2000). Separate groups of *H. azteca* were exposed to reference sediment for comparison of growth and survival. Four replicates per sediment were used.

A static exposure design was used, which permitted toxicants to accumulate in a worst-case exposure scenario (Nebeker et al. 1984). Deionized water was added daily as necessary to ensure water volume remained constant (Rand 1995). Water quality measurements (temperature, pH, dissolved oxygen, conductivity, and hardness) were collected on overlying water composited from the four test chambers for each sediment sample on day 10. Living organisms were also isolated on day 10 using a #40 U.S. Standard sieve (425 μm) and visually counted. Organisms were preserved in ethanol. Digital pictures were obtained at 2.5× magnification using a Leica MZ9.5 stereomicroscope (Leica Microsystems, Bannockburn, IL, USA). Organism length (mm) (curved dorsal surface from the base of the first antenna to the tip of the third uropod) was determined from these

pictures using Image J v. 1.45 (NIH). All organisms collected from each replicate were pooled and dry weights determined after drying to constant mass at 60°C.

Mean survival, mass, and length of *H. azteca* exposed to each sediment sample were compared to that of *H. azteca* exposed to reference sediment using one-way analysis of variance (ANOVA) followed by Dunnett's Test. Proportion surviving data were arc sine transformed in order to meet assumptions of normality. An alpha level of 0.05 was set for all statistical analyses. All statistical analyses were performed in R version 2.13.1 Statistical Software (R Development Core Team 2011).

Results

Inorganic analysis

Concentrations of Al, As, Cr, Fe, Cd, Pb, and Hg were determined for all sediments collected within the playa in May 2009 and February 2011 (Table 1). Aluminum was included in the analyses because elevated concentrations have been observed in sediments and soils of playas in the SHP (Venne et al. 2006). Check standards, instrument duplicates, and sample duplicates (mean ± standard error) were within 10.3 ± 2.1%, 3.3 ± 0.4%, and 13.8 ± 3.4%, respectively. Recoveries of lead from SRM NIST 2587 averaged 104 ± 6% (mean ± standard error) as compared to 76 ± 14% recovery of mercury from SRM NIST 1633b.

Mean concentrations of inorganic contaminants in sediments were below Texas Commission on Environmental Quality (TCEQ) ecological guidelines for sediment (TCEQ 2006; representing threshold effects concentrations for sediment dwelling organisms) with the exception of Pb, which exceeded the guideline of 35.8 $\mu g\,g^{-1}$ by 50% in 2011. Lead concentrations in sediment ranged from 0.24 to 173 $\mu g\,g^{-1}$ in 2009 and 7.05 to 250 $\mu g\,g^{-1}$ in 2011. Concentrations of As and Cd at some locations also exceeded TCEQ guidelines of 9.79 and 0.99 $\mu g\,g^{-1}$, respectively (TCEQ 2006). There are presently no TCEQ sediment guidelines for Li or Al.

Table 1. Mean (± standard error) dry weight concentrations ($\mu g\,g^{-1}$) of aluminum, arsenic, chromium, iron, cadmium, and lead, and mercury in sediments from sample locations SB #1, 6, 12, 16, and 17, northeast drainage ditch (NE DD), and a reference sediment. Sediments were collected from the I-20 Wildlife Preserve and Jenna Welch Nature Study Center, Midland, Texas, on May 13 and 14, 2009 and February 11, 2011.

Inorganic contaminant	2009 ($n = 92$)	2011 ($n = 12$)	Reference sediment	TCEQ guidelines[b]
Chromium	10.9 (0.7)	7.90 (0.88)	7.74	43.4
Arsenic	2.50 (0.14)	3.54 (0.75)	1.30	9.79
Cadmium	0.19 (0.03)	0.25 (0.05)	0.27	0.99
Lead	12.2 (2.9)	53.8 (20.1)	13.9	35.8
Aluminum	5487 (280)	2740 (410)	3077	NA[c]
Iron	3410 (270)	5790 (650)	7470	20,000
Mercury[a]	12.0 (1.0)	14.8 (3.7)	17.6	180

Notes: The reference sediment was collected from a grassland playa near Midland, Texas on April 13, 2011.
[a]Mercury concentrations are in $\mu g\,kg^{-1}$ as opposed to $\mu g\,g^{-1}$ as for the other trace elements.
[b]Texas Commission on Environmental Quality Ecological Risk Assessment Sediment Guidelines.
[c]Not available.

Organic analysis

Organic contaminants detected at locations within the playa wetland ranged widely from below detection limits to concentrations above TCEQ sediment quality guidelines (Table 2). Total PAH concentrations were 2420 and 661 $\mu g\,kg^{-1}$ in 2009 and 2011, respectively. Sediment concentrations of malathion, dieldrin, DDT, and DDE ranged from 58.2 to 71.8, 29.7 to 38.7, 40.0 to 70.5, and 25.2 to 34.0 $\mu g\,kg^{-1}$, respectively. Percent recoveries of internal standards were $99 \pm 16\%$ and $51 \pm 22\%$ for TCMX and DCBP, respectively. Maximum concentrations of dibenz[a,h]anthracene, dieldrin, DDT, DDE, and malathion were up to 3.5, 20, 17, 11, and 100 times greater than TCEQ sediment guidelines, respectively. Concentrations of acenaphthylene, pyrene, benzo[a]anthracene, chrysene, benzo[a]pyrene, and α-BHC were also above guidelines in sediments that had been collected in 2009 (TCEQ 2006). TCEQ guidelines are not yet established for benzo[g,h,i]perylene, indeno[1,2,3-cd]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and methoxychlor. All PCBs included in analysis were below limits of quantification. Based on the low recovery of the DCBP internal standard, PCB concentrations in sediments may have been underestimated.

Sediment toxicity tests

There was a significant decrease in the proportion of *H. azteca* surviving following exposure to sediments from core 6 (0–30.5 cm) compared to those exposed to the reference sediment ($F_{12,39} = 2.46$, $p = 0.041$; Figure 2a). There was a significant increase in mass for *H. azteca* exposed to sediments from sediment core NE DD (0–30.5 cm) compared to those exposed to the reference sediment ($F_{12,39} = 2.11$, $p = 0.050$; Figure 2b). No significant differences in length were observed between *H. azteca* exposed to sediments from the urban playa and reference site ($F_{12,39} = 1.59$, $p = 0.13$; Figure 2c). Water quality parameters were within acceptable ranges throughout the 10-day study (USEPA 2000).

Discussion

The objective of this study was to determine concentrations of inorganic and organic contaminants and toxicity of sediments in an urban playa located in the I-20 Wildlife Preserve and Jenna Welch Nature Study Center. Inorganic contaminants including lead, cadmium, and arsenic were quantified at concentrations greater than TCEQ sediment quality guidelines at some locations within the playa. Lead concentrations are often elevated near roadways and residential areas due to historic use of leaded gasoline and leaded paint, respectively (Cobb et al. 2006). This particular urban playa is located between US Interstate 20 and Industrial Avenue, so historical use of leaded gasoline may have contributed to increased concentrations of lead. However, identifying sources of inorganic contaminants in this playa is complicated by the presence of numerous potential nonpoint sources in the urban setting (Huang 1992).

Concentrations of some organic contaminants in sediments from this urban playa, particularly PAHs, DDT, DDE, and malathion, were also above TCEQ guidelines. Potential sources of low molecular weight and high molecular weight PAHs include fossil fuel combustion and the release of petroleum products, respectively (McGroddy and Farrington 1995). There is potential for small releases of crude oil from an oil well near the playa as a source of high molecular weight PAHs, while automotive exhaust emissions from the nearby roadways may be the source of low molecular weight PAHs

Table 2. Range (median) of dry weight concentrations ($\mu g\,kg^{-1}$) of polycyclic aromatic hydrocarbons and selected pesticides for sediments collected on May 13 and 14, 2009 and February 11, 2011 at the I-20 Wildlife Preserve and Jenna Welch Nature Study Center, Midland, Texas, and reference sediment collected on April 13, 2011, from a grassland playa near Midland, Texas.

Contaminant	Reference sediment	TCEQ guidelines[a]	2009 sediments[b]	2011 sediments[b]	Locations detected 2009 ($n=10$)	Locations detected 2011 ($n=12$)
Polycyclic aromatic hydrocarbons						
Acenaphthylene	ND[c]	5.9	7.02–7.03 (7.02)	ND	2	0
Fluorene	ND	77.4	5.79–18.4 (13.3)	5.64–19.2 (7.08)	6	5
Phenanthrene	6.35	204	7.32–441 (56.2)	6.78–309 (36.6)	10	12
Anthracene	ND	57.2	31.9	16.6–55.9 (36.2)	1	2
Pyrene	ND	195	6.42–1460 (409)	4.60–670 (64.8)	8	11
Benzo[a]anthracene	ND	108	13.6–902 (308)	8.63–335 (46.0)	7	10
Chrysene	ND	166	32.5–532 (149)	32.5–246 (40.5)	8	11
Benzo[b]fluoranthene	ND	NA[d]	27.7–413 (138)	19.9–145 (42.8)	7	10
Benzo[k]fluoranthene	ND	NA	7.79–7.81 (7.80)	ND	2	0
Benzo[a]pyrene	ND	150	19.2–519 (165)	20.4–173 (30.9)	7	10
Indeno[1,2,3-cd]pyrene	ND	NA	129–500 (411)	30.5–187 (51.1)	5	5
Dibenz[a,h]anthracene	ND	33	37.7–116 (89.0)	23.1–44.3 (36.8)	5	3
Benzo[g,h,i]perylene	ND	NA	12.5–394 (118)	12.9–130 (18.9)	7	9
Total PAHs	6.35	NA	2420	661		
Pesticides						
Malathion	0.00	0.67	61.6	58.2–71.8 (67.4)	1	4
α-BHC	37.28	6	18.4	ND	1	0
Dieldrin	0.00	1.9	29.7	38.6	1	1
p,p′-DDT	63.07	4.16	40.0–70.5 (55.1)	57.6–69.8 (63.6)	10	12
p,p′-DDE	0.00	3.16	25.2–34.0 (29.6)	25.2–32.0 (28.6)	2	2
Methoxychlor	0.00	NA	34.1–122 (66.2)	34.1–82.4 (39.5)	6	7

Notes: Concentrations are ranges of compounds detected at sediment sample locations 1, 6, 12, 16, 17, and northeast drainage ditch.
[a]Texas Commission on Environmental Quality Ecological Risk Assessment Sediment Guidelines.
[b]No range of values as contaminant was detected in only one sediment sample.
[c]Not detected.
[d]Not available

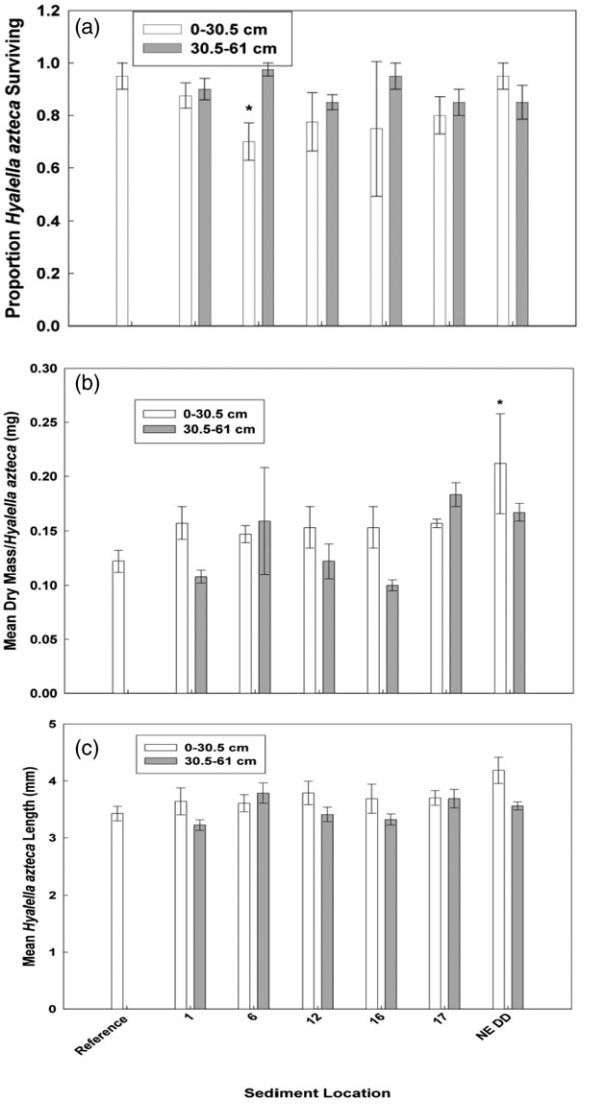

Figure 2. Proportion *H. azteca* surviving (a), mean dry mass per *H. azteca* (b), and mean *H. azteca* length (c) for a reference sediment and the 0–30.5 and 30.5–61 cm sediment cores for locations 1, 6, 12, 16, 17, and northeast drainage ditch within the playa on the I-20 Wildlife Preserve and Jenna Welch Nature Study Center, Midland, Texas. Error bars represent standard errors. Asterisk indicates a significant difference from the reference sediment from a grassland playa near Midland, Texas using Dunnett's Test.

(McGroddy and Farrington 1995). Increased concentrations of DDT and DDE have been attributed to the historical use of DDT in Texas (Venne et al. 2008). Increased concentrations of malathion may have been due to urban mosquito control efforts or insecticide use on nearby cotton crops (USEPA 2009).

Mean concentrations of inorganic contaminants in sediments from this urban playa were below those in sediments in agricultural and grassland playas reported elsewhere

(Irwin et al. 1996; Venne et al. 2006). Lead concentrations in sediments from several locations, including locations 1, 6, 12, 17, and NE DD, were greater than those in agricultural and grassland playas (Irwin et al. 1996; Venne et al. 2006). Concentrations of several organic contaminants, particularly PAHs and pesticides, were greater than concentrations in agricultural and grassland playas. Sediment concentrations of two PAHs, fluorene and phenanthrene, were up to 10 and 20 times greater, respectively, in this urban playa compared to those in agricultural and grassland playas (Irwin et al. 1996). Sediment concentrations of *p*,*p*′-DDT, *p*,*p*′-DDE, dieldrin, and α-BHC were three, 15, 30, and 10 times greater, respectively, than mean sediment concentrations of grassland and agricultural playas (Venne et al. 2008). Compared to other urban playa studies, which have only examined inorganic contaminants, sediment concentrations were quite similar compared to those found in this study. However, lead concentrations were higher, but within the same order of magnitude, while mercury concentrations were an order of magnitude higher in the urban playa from this study compared to other urban playas (Huang 1992; Arefeen 1995).

In this study, it was not feasible to determine all possible contaminants that may have been present in urban playa sediments (USEPA 2007). Further, chemical screening alone may have incorrectly predicted toxicity of chemical mixtures due to uncertainty associated with chemical interactions and bioavailability (Long and Morgan 1991; Traina and Laperche 1999). Despite several contaminant concentrations exceeding TCEQ guidelines, minimal toxicity was observed in *H. azteca* following exposure to sediments collected throughout the site. The TCEQ guidelines are single chemical threshold effect concentrations for sediment dwelling organisms obtained from MacDonald, Ingersoll, and Berger (2000). These guidelines were used to indicate potential for toxicity; however sediment toxicity tests were performed because multiple contaminants were present in sediments. The location exhibiting mortality also produced the highest concentrations for five of seven inorganic constituents, Cr, Pb, Al, Fe, and Hg. These results may be attributable to the location of core 6, which was situated at the lowest elevation within the playa (Ducks Unlimited 2010) where materials carried in runoff may have eventually settled. However, the ecological relevance of reduced survival of *H. azteca* exposed to sediments from a single location within the playa is likely minimal.

Chemical contaminants associated with urban playas have not heretofore been extensively studied. To our knowledge, this is the first characterization of inorganic and organic contaminants in an urban playa. Many of the inorganic and organic contaminants quantified in this study may have resulted from automotive emissions and historical pesticide use. Data presented in this study will serve as a baseline for future studies conducted in this and other urban playas. Continued monitoring of contaminants in sediments and expanded toxicity testing would provide information on how land-use changes around and within the I-20 Wildlife Preserve and Nature Study Center affect contaminants present in sediments and their associated toxicity. Similar studies performed on other urban playas throughout the SHP are needed to more fully understand how contaminants associated with urban settings affect these unique ecosystems.

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