Marine Pollution Bulletin 126 (2018) 166–178

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

# Mercury content of blue crabs (*Callinectes sapidus*) from southern New England coastal habitats: Contamination in an emergent fishery and risks to human consumers

David L. Taylor*, Nicholas M. Calabrese

*Roger Williams University, Department of Marine Biology, One Old Ferry Road, Bristol, RI 02809, USA*

ARTICLE INFO

*Keywords:*
Mercury
Accumulation
Blue crab
*Callinectes sapidus*
Prey
Sediment
Consumption advisory

ABSTRACT

Total mercury (Hg; ppm dry weight) was measured in blue crabs, *Callinectes sapidus*, collected from Narraganset Bay and adjacent coastal lagoons and tidal rivers (Rhode Island/Massachusetts, USA) from May to August 2006–2016. For juvenile crabs (21–79 mm carapace width, CW), total Hg was significantly greater in chelae muscle tissue (mean ± 1 SD = 0.32 ± 0.21 ppm; $n = 65$) relative to whole bodies (0.21 ± 0.16 ppm; $n = 19$), and irrespective of tissue-type, crab Hg was positively related to CW indicating bioaccumulation of the toxicant. Across a broader range of crab sizes (43–185 mm CW; $n = 465$), muscle Hg concentrations were significantly higher in crabs from the Taunton River relative to other locations (0.71 ± 0.35 ppm and 0.20 ± 0.10 ppm, respectively). Spatial variations in crab Hg dynamics were attributed to habitat-specific Hg burdens of their prey, including bivalves, gastropods, polychaetes, and shrimp. Prey Hg, in turn, was directly related to localized sediment Hg and methylmercury conditions. Biota-sediment accumulation factors for crabs and prey were negatively correlated with sediment organic content, verifying that organically-enriched substrates reduce Hg bioavailability. From a human health perspective, frequent consumption of crabs from the Taunton River may pose a human health risk (23% of legal-size crabs exceeded US EPA threshold level); thus justifying spatially-explicit Hg advisories for this species.

## 1. Introduction

Chemical contaminants are pervasive in many aquatic ecosystems, and their persistence in the environment may adversely affect the health of wildlife and humans (Fleeger et al., 2003; Johnston et al., 2015). Mercury (Hg) is specifically recognized as one of the most ubiquitous of these contaminants (US EPA, 1997), and chronic exposure to its organic form, methylmercury (MeHg), causes deleterious effects to the neurological, cardiovascular, immunological, and reproductive systems of biota (Hong et al., 2012). The extent of these health deficits depends on the magnitude and duration of MeHg exposure, which is affected by intra-specific life history traits (e.g., diet, growth, and longevity) and in situ physico-biogeochemical conditions that govern MeHg cycling in the environment (Chen et al., 2008). For the former, MeHg bioaccumulates in organismal tissues when the assimilation of the contaminant exceeds depuration rates (Evans et al., 2000). Moreover, MeHg biomagnifies across successive trophic levels, resulting in elevated MeHg concentrations in larger/older organisms and top-level consumers (Andres et al., 2002; Wiener et al., 2003; Olivero-Verbel et al., 2008; Reichmuth et al., 2010). From a human health perspective, MeHg exposure results from the consumption of contaminated fish and shellfish (Hightower and Moore, 2003; Taylor and Williamson, 2017), and MeHg typically constitutes > 95% of the total Hg burden in high trophic level species (Adams and Engel, 2014). Further, the majority of wild-caught fish and shellfish consumed by humans are of estuarine and marine origin (US EPA, 2002; Sunderland, 2007), thus emphasizing the need for toxicological research in coastal fisheries.

Estuarine and coastal habitats of the northeastern US receive substantial Hg loadings from atmospheric deposition, riverine inputs, and local point sources (Thompson, 2005; Chen et al., 2008; Taylor et al., 2012). The majority of Hg that enters these aquatic ecosystems is deposited in sediments (Balcom et al., 2004), after which inorganic Hg is methylated to MeHg by anaerobic, sulfate-reducing bacteria (Gilmour et al., 1992; Benoit et al., 2003). Methylation rates are often accelerated in estuarine and coastal sediments because these areas receive substantial anthropogenic inputs of inorganic Hg (Varekamp et al., 2003; Conaway et al., 2007; Fitzgerald et al., 2007) and maintain ideal physico-biogeochemical conditions for MeHg production and mobilization (e.g., frequent anoxia, elevated levels of organic material and sulfate, active bacterial communities, and optimal hydrodynamics at the

* Corresponding author.
*E-mail address:* dtaylor@rwu.edu (D.L. Taylor).

https://doi.org/10.1016/j.marpolbul.2017.10.089
Received 3 July 2017; Received in revised form 26 October 2017; Accepted 30 October 2017

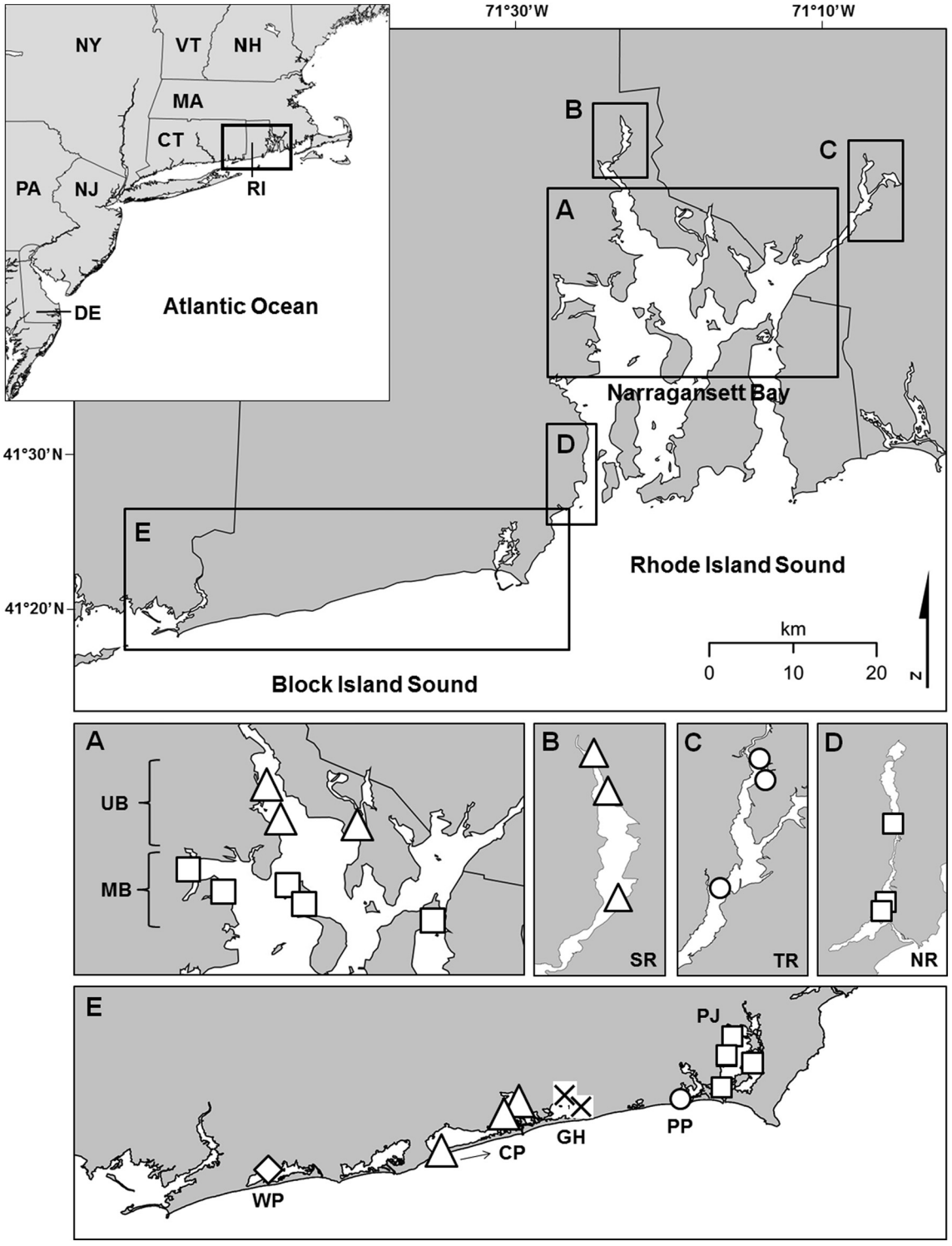


**Fig. 1.** Map of the three habitats examined in this study, including the Narragansett Bay (bay), coastal lagoons (lagoon), and tidal rivers (river), with points denoting collection sites of blue crabs. For analysis purposes, the bay was partitioned into two locations: upper Bay (UB) and mid-Bay (MB). Lagoon locations included the Charlestown Pond (CP), Green Hill Pond (GH), Point Judith Pond (PJ), Potter's Pond (PP), and Winnapaug Pond (WP), and river locations included the Narrow River (NR), Seekonk River (SR), and Taunton River (TR).

sediment-water interface; Chen et al., 2008). Importantly, the causative factors that regulate MeHg dynamics in estuarine and coastal habitats vary over relatively small spatiotemporal scales (Chen et al., 2008). Thus, monitoring MeHg contamination in these ecosystems requires insight into localized biogeochemical conditions that affect MeHg production, mobilization, and subsequent incorporation and transfer in food webs (e.g., sediment characteristics and biotic life history traits), and, in addition, research must be conducted over requisite temporal scales (Mathieson et al., 1996; Sager, 2002). These efforts are necessary to evaluate the mechanisms underlying intra-specific MeHg contamination and to properly assess ecological and human health risks (Taylor et al., 2012).

The blue crab, *Callinectes sapidus*, is a portunid crustacean that has a documented range between the coastal waters of Nova Scotia and Argentina (Millikin and Williams, 1984). Maximal abundances of blue crabs have historically occurred in the Middle-Atlantic Bight, with only