Science of the Total Environment 409 (2011) 4536–4544

Contents lists available at ScienceDirect

Science of the Total Environment

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

Consumption patterns and risk assessment of crab consumers from the Newark Bay Complex, New Jersey, USA

Kerry Kirk Pflugh [a], Alan H. Stern [a,*], Laura Nesposudny [b,1], Lynette Lurig [a], Bruce Ruppel [a], Gary A. Buchanan [a]

[a] New Jersey Department of Environmental Protection, 401 E. State St., P.O. Box 402, Trenton, NJ 08625–0402, United States
[b] Former intern with the New Jersey Department of Environmental Protection, United States

ARTICLE INFO

Article history:
Received 1 March 2011
Received in revised form 29 June 2011
Accepted 5 July 2011
Available online 24 August 2011

Keywords:
Risk
Consumption
Crabs
Advisories
Dioxin

ABSTRACT

The Newark Bay Complex (NBC) is a significant historical repository of polychlorinated dibenzodioxins (PCDDs) and dioxin-like compounds. Detection of high levels of 2,3,7,8 tetrachloro-dibenzodioxins (TCDD) and its toxicological equivalents in blue crabs in the early 1990's led to a ban on the taking and distribution of crabs from the NBC. Despite this ban and ongoing communication outreach, surveys of crabbers in 1995, 2002 and 2005 by the New Jersey Department of Environmental Protection (NJDEP) showed that crabbing for recreational purposes and for significant dietary supplementation was continuing. At the time they were surveyed, the crabbers had been consuming these crabs for an average of 37% of their lives. Thus, exposure can be considered chronic. The surveys provided data on the duration, frequency and amount of NBC crab consumption. In 2004, the NJDEP sampled blue crabs in the NBC and analyzed the edible portions for 2,3,7,8 TCDD toxicity equivalent (TEQ) concentration. We have combined the survey-based exposure data and the 2,3,7,8 TCDD TEQ concentration data to produce an estimate of the lifetime cancer risk to NBC crabbers from dioxin-like compounds. We employed a point-estimate approach using discrete lower, central tendency and reasonable maximum exposure (RME) estimates of exposure factors and a probabilistic approach to exposure factors. Both approaches show central tendency lifetime cancer risk of greater than one-in-a-thousand (10^{-3}) and an upper percentile/RME risk of approximately one-in-a-hundred (10^{-2}). Little extrapolation is involved in applying the 2,3,7,8-TCDD TEQ concentration data in crabs to risk estimates in the population consuming those crabs. The ongoing and frequent nature of the crab collection minimizes the uncertainty often inherent in food recall surveys. These estimates point to the continued risk posed to NBC crab consumers and to the continuing importance of this resource which, with proper remediation, could provide ongoing benefit to the surrounding community.

1. Introduction

Recreational crabbing in the urban northeast of New Jersey takes place next to industrial, commercial and residential land use. Public piers and other access points provide urban crabbers opportunities to pursue their catch. Initial state and federal surveys starting in the 1970s, as well as subsequent surveys found high levels of polychlorinated biphenyls (PCBs) in fish and crabs in the Hudson River and throughout the New York–New Jersey Harbor (Hetling et al., 1978; Belton et al., 1982; Belton et al., 1983; Hauge, 1993) and elevated levels of polychlorinated dibenzodioxins in species of finfish and blue claw crabs in the Newark Bay Complex (NBC) (Belton et al., 1985; Cristini and Gross, 1993) and New York–New Jersey Harbor Estuary (Skinner et al., 1997). The NBC includes the Lower Passaic River, Newark Bay, Lower Hackensack River, Kill Van Kull and the Arthur Kill (Fig. 1).

Among the dioxin-like compounds, which include the polychlorinated dibenzodioxins (PCDDs), the polychlorinated dibenzofurans (PCDFs) and the co-planar polychlorinated biphenyls (co-planar PCBs), 2,3,7,8-tetrachlorinated dibenzodioxin (2,3,7,8-TCDD) is one of the most biologically potent (Van den Berg et al., 2005). Dioxins are an unwanted industrial byproduct formed through numerous processes, including production of chlorinated phenol products such as herbicides, the incineration of municipal solid waste, and creation of paper products using bleach (USEPA, 2003) . Much of what is known about the toxicity of 2,3,7,8-TCDD has been derived from animal testing. In those systems, it has produced a number of effects including suppression of the immune system, impaired reproduction, alterations in liver function, cardiovascular disease, diabetes, porphyria, reduced testosterone and thyroid hormones, and altered

* Corresponding author at: New Jersey Department of Environmental Protection, Office of Science, Mail Code 428-01, PO Box 420, Trenton, NJ 08625-0420, United States. Tel.:+1 609 633 2374; fax: +1 609 292 7340.
E-mail address: Alan.Stern@dep.state.nj.us (A.H. Stern).
[1] Can be contacted through the corresponding author.

0048-9697/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.scitotenv.2011.07.017

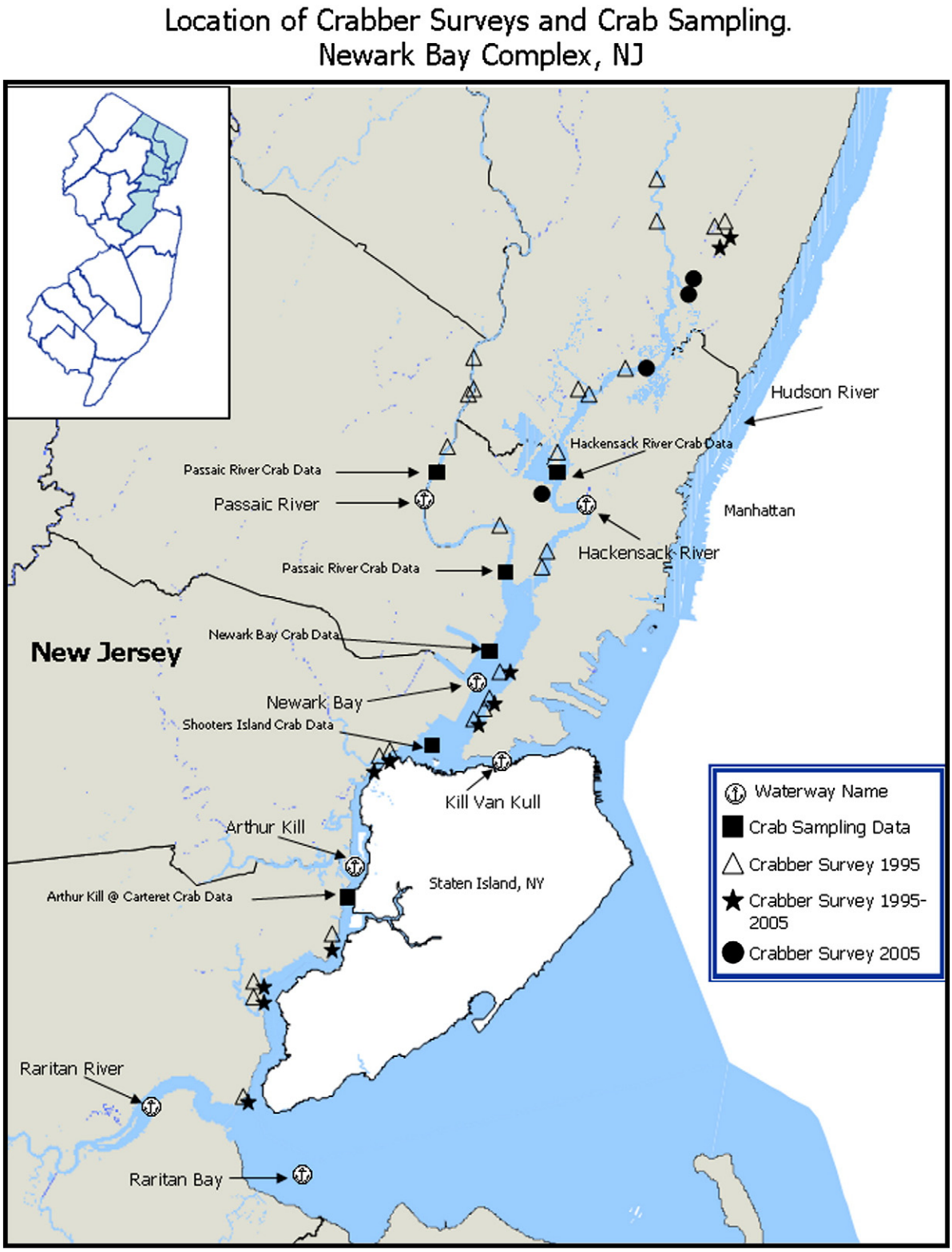

Fig. 1. Location of crabber surveys and crab sampling. Newark Bay Complex, New Jersey, USA.

immunologic response. Developmental effects include changes in neurobehavior, cognition, dentition, thyroid and immune status, and reproductive organ development, as well as altered sex ratios among exposed offspring (USEPA, 2003; White and Birnbaum, 2009). Finally, The US Environmental Protection Agency (EPA) has classified 2,3,7,8-TCDD and related compounds as probable human carcinogens (USEPA, 2003). Activation of the Aryl hydrocarbon Receptor (AhR) has been identified as a common mechanism of action for the biochemical effects of dioxins on vertebrates (USEPA, 2003; White and Birnbaum, 2009).

PCDDs and dioxin-like compounds have been found worldwide in edible marine species including crab (Domingo and Bocio, 2007). Food, including seafood, is the major pathway pf human exposure (USEPA, 2003). Similar instances of elevated dioxin contamination