FINAL DATA REPORT
FOR THE
VIEQUES ISLAND BIOTA SAMPLING PROJECT

VIEQUES ISLAND, PUERTO RICO

Prepared by

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and

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CITATION

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CONTACT INFORMATION

For more information about this report or to obtain a copy, please visit <HTTP://mapping.orr.noaa.gov/website/portal/vieques/projectscrab.html> or contact Mike Buchman, NOAA/NOS/OR&R at (206) 526-6340.

EXECUTIVE SUMMARY

In June 2005, the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (ORR) conducted an investigation of land crab (*Cardisoma guanhumi*) and fiddler crab (*Uca spp.*) from Vieques Island, Puerto Rico. Assistance was provided by the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (USEPA), the Puerto Rico Environmental Quality Board (EQB), and RIDOLFI Inc. under contract to NOAA. The primary purpose of the investigation was to characterize concentrations of explosive compounds, polychlorinated biphenyls (PCBs), organochlorine pesticides, and trace elements in land and fiddler crab. In addition, the Agency for Toxic Substances and Disease Registry (ATSDR) has used the land crab data presented in this report to write a Public Health Consultation (PHC), which is included in this report as Appendix H. Prior, limited investigations have been conducted by the ATSDR, the USFWS, and researchers from the University of Puerto Rico: this investigation was designed in part to build upon those previous efforts.

Results from the evaluations by ATSDR and NOAA will assist the USFWS in determining whether selected refuge areas can be opened to crab harvesting. In the future, the U.S. Navy, the USEPA, and the Puerto Rico EQB may also use portions of the land and fiddler crab data, as appropriate, in a full human health and ecological risk assessment for portions of Vieques Island.

From the 1940s until 2003, a portion of Vieques Island was used for military training exercises (gunfire and bombing). In 2001, the U.S. Navy transferred ownership of approximately 3,000 hectares (7,500 acres) of land on the west end of the island to the municipality of Vieques, the Puerto Rico Conservation Trust, and the USFWS. On May 1, 2003, the U.S. Navy ceased all military operations on and around the island and transferred its property on the east end of the island (approximately 5,800 hectares [14,575 acres]) to the USFWS. The land on the east end of the island and the land controlled by the USFWS on the west end of the island were then designated a national wildlife refuge. Approximately 9,300 Puerto Ricans live in the residential section of the island, which lies between the east and west ends. Land crab are an important subsistence resource to these islanders.

For the current investigation, land and fiddler crab were sampled from mudflats, mangrove wetlands, coastal forested areas, and sandy areas on the east and west ends of Vieques Island. Land crab were collected because of their importance in the diet of the island's residents. Fiddler crab were collected because they live in similar habitats, yet represent a slightly different pathway in the food web and serve as an additional indicator species for potential contaminant uptake. Because of their small size, a composite sample of fiddler crab also represents a far greater number of individuals per sampling station than is possible with the land crab.

Five to six individual land crab were collected from each of 12 sampling locations, which mainly represented potential or known harvest areas. Two reference locations of similar habitat were also sampled. Three composite samples of fiddler crab were collected at each of 12 sampling locations and one reference location: no fiddler crab were present at the on-island, Blue Horizon reference site. Following sample collection, the land crab and fiddler crab were processed and shipped according to the methods described in the *Final Sampling and Analysis Plan for the Vieques Island Biota Sampling Project*. Individual whole body land crab samples and composite, whole-body fiddler crab samples were analyzed for explosive compounds, PCBs, organochlorine pesticides, and trace elements. A limited number of land crab samples were subdivided into exoskeleton (i.e., the carapace and other parts of the shell) and soft tissue-only samples and these fractions were analyzed separately for trace elements. All analytical data were independently reviewed and validated to ensure their usability.

The fiddler crab data were compared to conservative ecological screening benchmarks; these conservative values provide a high degree of confidence that contaminant concentrations that do not exceed the benchmarks will not pose substantial adverse risk. Conversely, contaminant concentrations in excess of the conservative benchmarks do not necessarily indicate a definitive problem, but indicate the need for more detailed evaluations. Some of the benchmarks are specific to the protection of crab; when crustacean-specific benchmarks were not available, benchmarks protective of wildlife that eat contaminated prey (birds or small mammals) were used. Land crab data were also compared to just the crustacean-specific benchmarks, which include all organic benchmarks, cadmium, mercury, and vanadium.

Results generally indicate minimal occurrence of organic chemicals. Concentrations of many organic chemicals were below the sample-specific method detection limits (MDLs), and many of the detected values were just slightly above the MDLs. Explosive compounds were not detected in any land or fiddler crab. PCB compounds were detected in samples from only one area: Aroclor 1260 was found in a single land crab sample from Laguna Kiani, while Aroclor 1254 was found in all three fiddler crab composites from that sampling location. PCB concentrations in the crab samples, however, were well below the conservative ecological screening benchmark. PCBs have been reported by the U.S. Navy in the groundwater at Laguna Kiani in the past.

Unlike other organics, organochlorine pesticides, predominantly DDT and its metabolites, were detected in multiple land and fiddler crab samples. Levels of total DDT were generally higher in fiddler crab than in land crab, but there was concordance between the two species in the general pattern of sites having the highest average concentrations. Laguna Kiani, Red Beach, Blue Beach, and Bahia Tapon displayed higher concentrations of total DDT in both land and fiddler crab. The composition of DDT compounds does not suggest ongoing releases. These results are similar to those found in previous investigations.

The second most commonly detected pesticide was chlordane and its related compounds. Chlordane compounds were detected near the MDL in land crab from half of the sampling areas, including the on-island Blue Horizon reference location. Total chlordane (the sum of eight compounds) was detected at concentrations usually near the MDL in fiddler crab from all sampling locations except Mosquito Bay, including samples from the Humacao Wildlife Reserve reference location on mainland Puerto Rico. Again, there was concordance between the two species, with Laguna Kiani and Bahia Tapon having the highest total chlordane levels.

The occurrence of other pesticides was generally limited and sporadic. Aldrin, endrin, and dieldrin were detected at one to two sites each. Mirex was observed in most land crab and all fiddler crab samples only from the Live Impact Area (LIA). No pesticide concentrations in land or fiddler crab exceeded any ecological screening benchmarks.

As in previous investigations, trace elements were ubiquitously detected in both land and fiddler crab samples across all sampling locations. The widespread detection of numerous trace

elements in crab samples likely reflects exposure to elements naturally occurring in soil, sediment, groundwater, and surface water. Elevated levels, especially those significantly greater than the reference site, tend to suggest the potential for exposure to anthropogenic sources. In general, the results are variable. Differences were observed both within and among sampling areas, from element to element, and between the two crab species. However, there were observations of concordance between the two species that tend to suggest consistent exposures.

In land crab, average concentrations of beryllium, iron, mercury, selenium, thallium, uranium, vanadium, and zinc were either not different among locations or were not significantly greater than concentrations at the reference locations. For all other trace elements, at least one area had significantly greater concentrations than were observed at a reference location. However, in some cases this was because of elevated concentrations measured in a single crab.

In its PHC, the ATSDR concluded that levels of PCBs, organochlorine pesticides, and trace elements found in land crab were much lower than levels reported in the scientific literature as causing harmful health effects. Therefore, the ATSDR does not expect harmful health effects to occur in adults and children as a result of eating land crabs from Vieques Island. DDE concentrations were also below the Food and Drug Administration's regulatory limit for shellfish consumption.

The land crab data were also screened against ecological screening benchmarks for cadmium, mercury, and vanadium meant to be protective of other crustacean species. All concentrations of mercury were below the ecological screening benchmark. Vanadium concentrations were either below the MDL or above the screening benchmark. Average vanadium among areas did not differ from means observed from either reference though, suggesting that vanadium levels may represent baseline conditions. The cadmium benchmark was exceeded in four samples from three sampling locations (Boca Quebrada, Laguna Kiani, and the LIA). Levels in crab from the LIA were significantly greater than those from either reference. This ecological screening indicates that the possibility of adverse impacts to land crab due to the body burden of cadmium, and perhaps vanadium, cannot be eliminated for some specific areas.

One land crab from each sampling area was dissected into exoskeleton and soft tissue fractions, which were analyzed separately for trace elements. The purpose was to evaluate the two fractions for indications of preferential bioconcentration. In general, more compounds were detected in the soft crab tissue than in the exoskeleton. The exoskeletons did not contain beryllium, mercury, or selenium. Concentrations of half of all detected trace elements were greater in the exoskeleton than in the soft tissue; concentrations of barium, calcium, chromium, and magnesium were at least an order of magnitude greater. Average cadmium, copper, silver, and zinc concentrations were three to ten times higher in the soft tissue.

Concentrations of beryllium, manganese, mercury, nickel, thallium, and uranium in fiddler crab did not exceed ecological screening benchmarks in any samples. No benchmarks were available for cobalt, iron, and silver. Concentrations of ten trace elements measured in fiddler crab exceeded ecological screening benchmarks in one or more samples. Of these, aluminum, arsenic, vanadium, and zinc exceeded wildlife screening benchmarks in all samples from all sampling areas, including the reference location. Concentrations of barium, cadmium, chromium, copper, and selenium exceeded screening benchmarks to varying degrees and at various locations. Lead concentrations exceeded the benchmark at only one location (Laguna Kiani). Three of the compounds that exceeded benchmarks (cadmium, lead, and selenium) were not detected in the Humacao Wildlife Reserve reference samples at concentrations above the benchmarks.

The occurrence of PCBs in both land crab and fiddler crab from Laguna Kiani, which is coincident with past reports by the US Navy of PCBs in groundwater at this same site, demonstrate that PCBs at this location are bioavailable and capable of entering the food web. The co-occurrence of maximum concentrations of other contaminants in these same samples for both species suggests that other contaminant releases may be occurring within this area as well. Although the concentrations of organics reported here are below screening benchmarks, the limited extent of sampling in this preliminary study makes it difficult to draw firm conclusions regarding the degree of risk that releases at this site may pose. Further characterization of the nature and extent of releases at this site is recommended as part of the ongoing remedial investigation or as monitoring to verify the effectiveness of removal actions.

The concordance observed between the two species in some contaminants detected may indicate exposure pathways at other sites as well. Examples include mirex, arsenic, and cadmium observed at the LIA and total DDT at Blue Beach, Red Beach, and Bahia Tapon. Although values were below screening benchmarks, these observations demonstrate an exposure mechanism for these areas.

The screening-level assessment presented in this report should not be viewed as a full ecological risk assessment. This screening assessment applied conservative assumptions about exposure that are not necessarily realistic or appropriate for characterizing actual risk. Instead, it offers a high level of confidence in determining situations where a low probability of adverse impacts are present, and facilitates determining the need for, and degree of, further investigation. The screening-level assessment acknowledges that any chemical concentrations exceeding the conservative benchmark values may be considered *potentially* hazardous, although they are not necessarily so until further, more realistic, site-specific assessments determine this. The preliminary screening of crab chemical body burdens presented here cannot eliminate the possibility that some analytes may be present at levels sufficiently high to cause adverse impacts to crab. To fully identify and characterize potential risk to the environment, further analysis of appropriate portions of these data, as well as evaluations for other ecological receptors, may be warranted, particularly with regard to PCBs, total DDT, and some trace elements. The need for additional evaluation, as applicable, should be determined in the human health and environmental risk assessment activities required for the ongoing remedial investigation of sites on Vieques Island.