Liver Lesions in Winter Flounder
(Pseudopleuronectes americanus) from Jamaica Bay, New York: Indications of Environmental Degradation

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ABSTRACT: Liver sections of winter flounder (Pseudopleuronectes americanus) collected from Jamaica Bay and Shinnecock Bay, New York, in 1989, were examined microscopically to determine the pervasiveness of liver lesions observed previously in Jamaica Bay winter flounder. Neoplastic lesions were not detected in fish from Jamaica Bay or the Shinnecock Bay reference site. Twenty-two percent of Jamaica Bay winter flounder examined (n = 103) had unusual vacuolization of hepatocytes and biliary pre-ductal and ductal cells (referred to hereafter as the vacuolated cell lesion). The lesion, identical to that found in 25% of Jamaica Bay winter flounder examined in 1988, has previously been identified in fishes taken from highly polluted regions of the Atlantic coast (e.g., Boston Harbor, Massachusetts, and Black Rock Harbor, Connecticut). Prevalence of the vacuolated cell lesion in winter flounder from Jamaica Bay was significantly greater (p < 0.0001) than in 102 specimens collected from Shinnecock Bay. Current scientific literature indicates vacuolated hepatocytes and cholangiocytes are chronically injured and that the extent of their deformity is consistent with the action of a hepatotoxicant. The high prevalence of vacuolated hepatocytes in Jamaica Bay winter flounder and absence of the lesion in flounder from reference sites strongly supports the hypothesis that this impairment is a manifestation of a toxic condition in at least some portions of Jamaica Bay.

Introduction

The Jamaica Bay/Breezy Point Unit of Gateway National Recreation Area, Brooklyn, New York, confronts the resource manager with a striking juxtaposition of biotic wealth and environmental degradation. The 52-km² coastal estuary’s diverse fishery includes 81 species of finfish and is heavily utilized for recreational angling (Heatwole and West 1983; Riepe et al. 1989). Jamaica Bay’s shallow open water and salt marshes, part of which are designated Jamaica Bay National Wildlife Refuge, provide full-time or seasonal habitat for about 300 species of birds and are frequented by Atlantic flyway ducks and geese during fall migration. The environmental quality of this urban park continues to be degraded by a diversity of point and non-point pollutant sources, including four sewage
treatment plants with a cumulative discharge of 320 million gallons per day, combined sewer and storm water overflows, atmospheric deposition, runoff from urban and commercial development, an international airport, and three defunct solid waste landfills (Tarancredi 1987, 1990). Two of the solid waste landfills are recognized as having received illegally deposited hazardous waste.

A number of environmental assessments indicate elemental, polycyclic aromatic hydrocarbon (PAH), and polychlorinated biphenyl (PCB) contamination of Jamaica Bay sediments, water, and biota (Tarancredi 1987, 1990; Seidemann 1991). The relative degree of sediment contamination in coastal and estuarine waters of the United States is monitored via the National Oceanic and Atmospheric Administration’s National Status and Trends Program. National Status and Trends Program samples from Jamaica Bay indicate that average concentrations, in parts per million (ppm) dry weight, of silver (3.6 ppm), arsenic (18.0 ppm), cadmium (1.4 ppm), copper (110 ppm), chromium (160 ppm), lead (130 ppm), mercury (1.5 ppm), tin (18 ppm), zinc (200 ppm), total PCBs (0.48 ppm), and total PAHs (4.5 ppm) are at the high end of the overall national distribution (National Oceanic and Atmospheric Administration 1991). The PAHs and PCBs are of particular interest because of their ability to produce neoplasia and other cellular disorders in populations of feral fish, particularly in species residing or feeding in close association with contaminated sediments (Meyers and Hendricks 1982; Baumann 1989; Harshbarger and Clark 1990; Myers et al. 1990).

To assess potential impacts to resident biota from contaminant inputs to Jamaica Bay, the National Park Service and United States Fish and Wildlife Service have conducted histopathological evaluations of Jamaica Bay winter flounder (Pseudopleuronectes americanus). Winter flounder are estuarine-dependent, bottom-dwelling fish that feed primarily on benthic macroinvertebrates. Winter flounder predominately reside in their spawning area for the first years of their lives; as they approach sexual maturity, they migrate out of the estuary to colder, offshore waters during summer months (Murchelano 1988; Buckley 1989). These factors make them an ideal sentinel in environmental pollution monitoring (Stich et al. 1976; Murchelano 1988; Harshbarger and Clark 1990). The winter flounder’s recreational importance in Jamaica Bay and use in earlier studies of the bay also supported its use for this study.

Histopathology provides a sensitive indicator of sublethal stress induced by environmental contaminants (Hunn 1988; Hinton and Lauren 1990). A previous histopathological investigation of Jamaica Bay winter flounder revealed a 25% prevalence of the vacuolated cell lesion in livers of specimens collected in the vicinity of the Pennsylvania Avenue landfill (United States Fish and Wildlife Service 1989). Similar, if not identical, lesions have been identified in winter flounder from highly polluted northeastern coastal waters including Boston Harbor and New Bedford Harbor, Massachusetts, and Black Rock Harbor, Connecticut (Murchelano and Wolke 1985; Gardner et al. 1987; Sass and Murchelano 1988).

This study was designed to reassess prevalence of the vacuolated cell lesion in Jamaica Bay winter flounder, and to determine if the lesion was present in winter flounder from a geographically similar but less environmentally impacted site. Shinnecock Bay is a shallow estuary on the southern shore of eastern Long Island. It is surrounded by a much less developed watershed than Jamaica Bay and serves as the reference location for this assessment. Shinnecock Bay sediments collected by the United States Environmental Protection Agency’s Environmental Monitoring and Assessment Program (EMAP) were analyzed for a suite of organic and elemental contaminants in 1990. Shinnecock Bay sediment concentrations of silver (<1.0 ppm), cadmium (0.92 ppm), chromium (74.0 ppm), copper (35.3 ppm), lead (61.1 ppm), mercury (0.27 ppm), tin (4.81 ppm), total PCBs (0.006 ppm), total PAHs (0.50 ppm), and total chlordane (0.002 ppm) are one to two orders of magnitude lower than concentrations in Jamaica Bay sediments (R. Lattimer personal communication).

Methods

Collection of Samples

Prior to collections, we determined that a sample of 100 fish would yield sufficient power to detect a disease prevalence of 3% or greater in winter flounder from either bay. In Jamaica Bay, 103 winter flounder were collected with an otter trawl from October 16 to November 6, 1989; their average length was 23.5 cm (range 19.0–35.1 cm) and average weight was 180 g (range 90–580 g). Jamaica Bay trawl locations are shown in Fig. 1. Winter flounder from Shinnecock Bay (n = 102) were collected by otter trawl (n = 55) and trap net (n = 47) from November 9 to December 6, 1989; their average length was 29.1 cm (range 20.1–44.1 cm) and average weight was 360 g (range 80–1,000 g).

Age of Jamaica Bay winter flounder was determined visually by counting annuli on plastic impressions of scales removed from the caudal peduncle (Fields 1988). Average age of specimens collected from Jamaica Bay was 3 yr (range 2–5 yr).