

Division of Science, Research and Technology

Research Project Summary

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Routine Monitoring Program for Toxics in Fish - Year 3 Raritan River Region

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Abstract

This New Jersey Department of Environmental Protection (NJDEP) monitoring program is the third year of a five-year program that builds upon prior fish contamination research. The program, conducted by the NJDEP's Division of Science, Research and Technology (DSRT), focuses on collection of fish species currently under fish consumption advisories due to chemical contamination, and to assess the status and trends of these contaminants in the state's aquatic systems. This year 3 program primarily examined the entire Raritan River Region. Samples were collected in 2006-07. In general, only a few of the samples exceeded high action levels (e.g., FDA Action Levels for mercury, PCBs, DDX and chlordane). However, the majority of samples did exceed various risk-based (human health) thresholds (utilized by the State) and in many cases, the individual specimens exceeded thresholds for several contaminants. Some sites, notably New Market Pond and the Bound Brook downstream of New Market Pond (several fish species) and Raritan Bay and South River (blue crab hepatopancreas tissue) had high concentrations of a variety of chemical contaminants. Low concentrations of contaminants were found in samples of summer flounder from Sandy Hook Bay and weakfish from Manahawkin Bay. Comparable samples of similar size species from the same sites collected in 1992 and 2006 DSRT studies revealed mercury concentrations generally similar between the two years. However, lower concentrations were seen in 2006 northern pike from Spruce Run Reservoir and largemouth bass from Carnegie Lake when compared to 1992. The patterns of contaminant concentrations in fish reflect individual fish characteristics such as size (typically higher in larger, older fish), trophic level (high mercury in top predators) and lipid content (for organic contaminants). Sample site differences, indicative of current or past point sources (e.g., New Market Pond) and regional differences also affect contaminant biogeochemistry. The data generated through the Routine Monitoring Program are used by NJDEP and NJDHSS to develop various fish consumption advisories for the fish consuming public.

Introduction

In the 1980s and 1990s, fish and shellfish consumption advisories due to toxic chemical contamination were announced in New Jersey. Data from DSRT studies revealed that unacceptable risks existed for eating certain species of fish and shellfish from certain waters in the State. These advisories particularly apply to pregnant women, nursing mothers and young children because polychlorinated biphenyls (PCBs), dioxin and mercury are known to cause birth defects, developmental problems, neurological problems and/or cancer. Current data are needed to assess the levels of toxics in fish & shellfish within NJ waters today. These data are also used to develop water quality assessments for specific waterways. Currently freshwater lakes, rivers and reservoir in the state that are listed as impaired in the 303d Water Quality Assessment Report. The 303d list drives the development of Total Maximum Daily Limits (TMDL)

and other contaminant control strategies. NJDEP has established certain areas of concern to address surface water and fish consumption advisories.

These areas include:

- **Establishing routine statewide fish tissue monitoring network for contaminants, target species and target water bodies.**
- Examining effectiveness of current consumption advisory education and outreach effort.
- Evaluate appropriateness of current fish consumption advisories and need for modifications.

The monitoring program described is the third year of a five-year program that builds upon DSRT fish contamination research. The program focuses on collection of those fish species currently under consumption advisories collected from waterways

identified with a specified chemical contamination. These data will provide a tool to assess the status and trends of these contaminants in the state's aquatic systems. Due to the large number of water bodies in the state, the program is divided into five broad water regions on a recurrent five-year cycle. These regions are generally adapted from five NJDEP watershed management regions, with the additional consolidation of two Delaware River Basin regions and compilation of all inshore coastal waters into a single Marine/Estuary Region.

The five regions are:

1. Passaic River Region
2. Marine/Estuarine Region.
- 3. Raritan River Region**
4. Atlantic Coastal Inland Waterways Region
5. Upper and Lower Delaware River Region.

The Academy of Natural Sciences, Philadelphia (ANSP) was contracted to conduct this Year 3 of the Monitoring Program. The monitoring program of the Raritan River Region includes the collection of fish species from the Raritan River main stem, tributaries and other waterbodies in Middlesex, Monmouth, Somerset, Hunterdon, Morris, Warren and Sussex counties. In addition, a limited number of estuarine and marine fish samples from the Raritan Bay, Lower Bay, Sandy Hook Bay, Northern Coastal Atlantic Ocean, Southern Coastal Atlantic and Barnegat Bay were also included to provide valuable data for these areas.

Freshwater Species		
American Eel	Chain Pickerel	Redbreast Sunfish
Black Crappie	Channel Catfish	Rock Bass
Bluegill	Lake Trout	Walleye
Brown Bullhead	Largemouth Bass	White Catfish
Brown Trout	Northern Pike	Yellow Bullhead
Bullhead	Smallmouth Bass	Yellow Perch
Carp	Striped/White Bass Hybrid	
Marine/Estuarine Species		
American Eel	Summer Flounder	White Catfish
Blue Crab	Weakfish	White Perch

Methods

The monitoring program design contains representative sampling of targeted fish from a subset of public assessable waterways throughout the state. Sampling site selection within both the freshwater and estuarine/marine components of the monitoring plan includes those lakes, rivers, reservoirs and coastal waterways under the current and recently proposed fish consumption advisories. These sites, derived from previous DSRT/ANSP research were chosen from a listing of publicly owned or assessable waters provided by Division of Fish and Wildlife. To ensure unbiased coverage, the sample site selection was made by using a random-stratified method and modified to include specific recreationally important waterways. Listed below are the fish and shellfish species collected and the suite of chemical contaminants analyzed.

Organochlorinated Pesticides	Polychlorinated biphenyls					
BHC (alpha, beta, gamma, delta)	1	25	100	82	183	203,196
Heptachlor	3	31,28	63	151	128	189
Heptachlor epoxide	4,10	33,21,53	74	134,144	185	208,195
Chlordanes (gamma and alpha)	6	22	70,76	107	174	207
Nonachlors (cis and trans)	7	45	66,95	149	177	194
Dieldrin	8,5	46	91	118	202,171	205
DDD's (o,p and p,p)	14	52	56,60	134	157,200	
DDE's (o,p and p,p)	19	49	101	131	172,197	206
DDT's (o,p and p,p)	12,13	47	99	146	180	209
Aldrin	18	48	83	132,153,105	193	Co-Planar PCB
Endosulfan I and II	17	44	97	141	191	77
Endrin	24,27	37,42	81,87	137,176	199	81
Oxychlordane	16, 32	41,71	85	158	170,190	126
Total Mercury	29	64	136	129,178	198	169
Dioxins and Furans	26	40	77,110	187,182	201	
PBDEs						

Total mercury was analyzed for all freshwater fish collected. A limited number of PCB (congener specific and calculated total Aroclor) and pesticide analysis (e.g., chlordane, DDX, etc.) were included where appropriate. All coastal estuarine and marine species were analyzed for PCB's and mercury and a limited number of samples were analyzed for dioxin, furan and polybrominated diphenyl ether (PBDE) compounds.

Results

Total mercury was measured on all of the 434 samples collected. PCBs and selected Organochlorine pesticides (OCPs) were measured on 261 of the samples with bioaccumulation potential. These samples included predatory species, benthic species and species with high lipid content. The OCPs reported include total DDX, total BHC+lindane, and total chlordanes. Also, of those specimens analyzed for PCBs and OCPs, polybrominated diphenyl ethers (PBDEs) were measured on 54 fish samples and 36 samples were analyzed for dioxin/furans.

Total mercury was detected in all of the 434 fish and crab samples tested. Levels of PCBs were found in all 261 samples tested from all locations. OCPs mirrored the PCB results and were identified in all 261 samples, however, only low levels of total BHC+lindane were identified in any sample tested and few samples had elevated concentrations of total DDX and total chlordanes. Only a limited number of total dioxin and furans contaminants were identified in any select freshwater and marine/estuarine samples. However, PBDEs (flame-retardants) were found in all samples tested.

Discussions

Based on mathematical pair-wise correlation, concentrations of several contaminants were correlated among samples. PCBs were highly correlated with BHCs and lindane and moderately correlated with DDX. Co-planar PCBs were not highly correlated with total PCBs, but were moderately correlated with PBDEs. In general, mercury was weakly correlated with the organic contaminants tested. Site specific correlation for concentrations of PCBs, chlordane and DDX were observed for samples from New Market Pond.

The US FDA promulgates guidelines for consumption of fish in the commercial markets that have been used to generate recreational fish consumption advisories. In addition, risk based assessments for consumption of recreationally caught fish have also been generated by the USEPA and the NJDEP/DHSS for mercury, PCBs, select OCPs and dioxin/furans. The states

action levels are often lower than FDA. The levels used by New Jersey are risk based and vary with a specific target consumer population (i.e., general population, high risk population) and often recommend a specific frequency of consumption (e.g., one meal per week) rather than setting a single "do not eat" level.

Mercury Database

The FDA Action level for mercury is 1 µg/g or 1.0 ppm (part per million). The NJDEP/DHSS criterion ranges from 0.08 – 0.54 ppm for the High Risk Population and 0.34 – 2.85 ppm for the General Population. The highest mercury level identified in an individual sample (1.413 ppm.) was observed in a largemouth bass from Farrington Lake. Although most levels found were below 0.50 ppm, mercury levels were elevated (>0.50 ppm) in individual fish samples from a number of freshwater lakes including Budd Lake, Carnegie Lake, Davidson Mills Pond, Delaware & Raritan Canal at Port Mercer and West Trenton, DeVoe Lake, New Market Pond, Rahway River at Milton Lake, Raritan River at Millstone River and Rt. 1 locations, Millstone River at Manville, Spruce Run Reservoir and Weston Mill Pond. The majority of elevated mercury concentrations were observed in top trophic level freshwater fish, such as largemouth bass, chain pickerel, hybrid striper and walleye, while only one of the marine/estuarine samples (i.e., white perch from the Raritan River at Rt. 1) exhibited an elevated mercury concentration.

PCB Database

The FDA "do not eat" Action Limit for total PCBs is 2000 ng/g. The NJDEP/DHSS PCB advisory triggers start at a concentration of 8 ng/g for the High Risk Population. NJ DEP/DHSS based the PCB advisory limits on both cancer and non-cancer end points. The greatest PCB concentrations were observed in samples from the New Market Pond (NMP) and vicinity. The highest PCB level (4870 ng/g) was found in American eel from the Bound Brook (directly) below the NMP dam. The highest levels in American eel and common carp samples from NMP itself were 4117 and 3057 ng/g respectively. PCB concentrations in other species (i.e., American eel, bluegill sunfish, largemouth bass, black crappie, and brown bullhead) from NMP and the vicinity (i.e., Spring Lake Tributary to Bound Brook, Bound Brook at Shepard Rd and Greenbrook at Madison Ave Bridge) were also relatively high compared to other sites.

Elevated levels of PCBs were also seen at various freshwater locations throughout the study region. The highest levels (other than NMP) were in common carp samples from Rahway River at Milton Pond and Valley Road Pond at 936 and 614 ng/g, respectively. Fish samples from the Raritan River and Millstone River

also had elevated PCB concentrations. Levels as high as 907 ng/g were found in common carp from the Millstone River at Manville and levels in white catfish from the Raritan River at Route 1 ranged from 711 to 666 ng/g. At the confluence of the Millstone and Raritan River PCB levels in the common carp and American eel were 528 and 497 ng/g, respectively. A single sample of American eel from the South Branch Raritan River at Flemington revealed a PCB level of 460 ng/g, and three American eel samples from High Bridge ranged from 456 to 405 ng/g. An American eel sample from Weston Mills Pond reached 417 ng/g. Samples from the Delaware & Raritan Canal showed higher than expected levels of PCBs as well. Samples of American eel collected at Lambertville, American eel, channel catfish, common carp and walleye from West Trenton, American eel and common carp from Port Mercer, American eel and channel catfish from both Griggstown and South Bound Brook all show elevated levels of PCBs.

Samples of marine/estuarine fish and crabs also produced elevated PCB concentrations. Samples of blue crab hepatopancreas from South River at Sayreville and Raritan Bay at Keansburg had relatively high levels of PCBs that ranged from 409 to 1135 ng/g and 779 to 1062 ng/g, respectively. In addition, South River exhibited elevated levels of PCBs in white catfish and white perch that reached 487 and 455 ng/g.

OCP Database

NJDEP/DHSS criteria for pesticides are based on cancer and non-cancer risks. Only low levels of total BHC+Lindane were identified in any sample tested, and none of the samples analyzed exceeded advisory limits. Elevated concentrations of other pesticides (e.g., total chlordane, DDXs) were identified in samples from New Market Pond (American eel and common carp), the Bound Brook below NMP (American eel), Weston Mills Pond (American eel), common carp from Rahway River at both Milton Pond and Valley Road Ponds, and blue crab hepatopancreas tissue from Raritan River, South River and Raritan Bay. American eel pesticide concentrations typically exceeded advisory thresholds in all waters tested, while carp and channel catfish often exceeded these thresholds.

Dioxin/Furan Database

NJDEP/DHSS uses dioxin/furan toxic equivalents (TEQ) criteria for generating fish consumption advisories. TEQs are calculated relative to 2,3,7,8-TCDD from other dioxin and furan congener concentrations identified in the samples. A limited number of dioxin and furans were analyzed in samples of common carp, white perch, blue crab and summer flounder. Samples were collected from freshwater sites at New Market Pond, Raritan River at Millstone River and the Rahway

River at Valley Road Pond. Marine/estuarine sites included Raritan River at Route 1, South River at Sayreville, Raritan Bay at Keansburg, Sandy Hook Bay, Lower bay and Atlantic Ocean North. Contaminant levels (TEQ) in the freshwater sites were highest in common carp from Raritan River at Millstone River and New Market Pond. For the marine/estuarine sites, TEQ levels were elevated in some samples of blue crab hepatopancreas tissue from the South River and Raritan River.

PBDE Database

PBDEs are among a number of flame retardant compounds that have recently been found in aquatic organisms throughout the world. Of the PBDEs that were found, the highest concentration (105.4 ng/g) was observed in a sample of blue crab hepatopancreas tissue from the South River at Sayreville. Another two samples of common carp from Raritan River at Millstone River exhibited levels of 63.6 and 61.8 ng/g ww, respectively. Three samples of blue crab hepatopancreas tissue from Raritan Bay at Keansburg ranged from 33.0 to 43.9 ng/g, and three samples of common carp from Rahway River and Valley Road Pond ranged from 23.1 to 37.5 ng/g.

Comparison of Mercury Concentrations with Previous Studies

Many of the waterbodies sampled in this project had not been previously sampled. A few sites that had been sampled for mercury in 1992 or 1996 were re-sampled in this project. However, the majority of the information generated through this project is new for the suite of organic contaminants tested. In general, where data were comparable the concentrations in this project were similar to those in earlier sampling efforts. The exception was seen in northern pike samples from Spruce Run Reservoir where the results for larger specimens collected in 2006 were less than samples collected in 1992. Mercury levels in largemouth bass from Carnegie Lake also tended to be lower in 2006 than 1992. However, in both cases, with the limited number of specimens analyzed, the differences observed can not be concretely attributed to changes in mercury availability.

Conclusions

This study is the third year of a five-year Routine Monitoring Program examining toxic chemical contaminants in New Jersey fish. The study included the analyses of a number of fish trophic (feeding) levels in the Raritan River Region that typically bioaccumulate specific organic contaminants. The study also investigated the patterns of bioaccumulation in a variety of fish taxa likely to be consumed and targeted by recreational anglers. The program is designed to address these different scales of variation by sampling a range of size of several species, by sampling new sites in each round to identify previously-unknown hotspots, by re-sampling selected sites to analyze temporal trends, and by

rotating among regions to investigate broad, regional patterns in fish contamination. The data generated is useful for assessing potential human health risks and environmental trend assessments. Several conclusions can be drawn from this body of work.

- 1) In general, few of the samples exceeded high action levels (e.g., FDA Action Levels for mercury, PCBs, DDX and chlordane). However, a number of samples exceeded various risk-based (human health) thresholds (utilized by the State) and in many cases, the same specimens exceeded thresholds for several contaminants.
- 2) Some sites, notably New Market Pond and Bound Brook downstream of New Market Pond, had high concentrations of several contaminants. Concentrations of the contaminants were considerably lower in fish from further downstream in Bound Brook at Shepard Road.
- 3) Blue crab hepatopancreas samples from Raritan Bay and South River had high lipid concentrations and high concentrations of several contaminants. Muscle tissue from the same specimens had low concentrations.
- 4) Where individuals of comparable sizes of the same species from the same site were analyzed in 1992 or 2006 program, mercury concentrations were generally similar between the two years. However, lower concentrations were seen in northern pike from Spruce Run Reservoir in 2006 than in 1992. Levels of mercury in largemouth bass from Carnegie Lake may also have been lower in 2006 than in 1992.
- 5) Low concentrations of contaminants were found in samples of summer flounder from Sandy Hook Bay and weakfish from Manahawkin Bay.
- 6) The patterns of contaminant concentrations identified in the fish sampled reflected individual fish characteristics such as size (typically higher in larger, older fish), trophic level and lipid content (for organic contaminants), site differences indicative of current or past point sources (e.g., New Market Pond) and regional differences which affect contaminant biogeochemistry.
- 7) The New Jersey Department of Environmental Protection (NJDEP) and Department of Health

and Senior Services (NJDHSS) use risk-based health criteria for establishing fish consumption advisories for mercury, PCBs, OCPs and dioxin. These criteria are typically lower than FDA thresholds for advisories for commercial fish. The data from this study and other portions of the routine monitoring program are used by NJDEP and NJDHSS to develop consumption advisories for New Jersey fish consumers.

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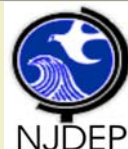


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