Measurement of strontium-90 (^{90}Sr) and other radionuclides in edible tissues and bone/carapace of fish and blue crabs from the lower Hudson River, New York

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INTRODUCTION

In 2005, Entergy Nuclear Operations, Inc. (Entergy), the owner of the Indian Point Nuclear Power Plant located at Buchanan, NY on the Hudson River, discovered a spent fuel pool water leak to groundwater while installing a new crane to facilitate transfer of Unit 2 spent fuel to dry cask storage. This leak was determined to have generated a groundwater plume of tritium (^{3}H). During efforts to track the ^{3}H plume, ^{90}Sr was discovered in a downgradient portion of the plume and traced back to a leak in the Unit 1 spent fuel pool.

Because site groundwater flows to the Hudson River, the 2006 Radiological Environmental Monitoring Program (REMP) conducted by Entergy was modified to include ^{90}Sr as an analyte in fish samples. ^{90}Sr was detected in four of 10 samples of fish taken from the river in the vicinity of the power plant, and in three of five samples from an upstream reference location near the Roseton Generating Station in Newburgh, NY (Table 1). The tissues analyzed were composites of edible flesh from fish representing several species.

The data was reviewed by Entergy and compared with data for other facilities and historical information. Entergy concluded that the ^{90}Sr levels were low and may be indistinguishable from background levels from fallout from nuclear weapons testing in the 1950's and 1960's (Entergy 2007). The New York State Departments of Health (NYSDOH) and Environmental Conservation (NYSDEC) (the Agencies) concurred. However, the Agencies were concerned that the home ranges of several sampled species, and all striped bass, may overlap at the two sampling sites. In order to assure independence of sampling sites, the Agencies initiated this one time enhanced radiological surveillance for 2007.

The objectives of the enhanced radiological monitoring effort were to:

- gain information about the levels, impacts, and possible ^{90}Sr sources at the reference locations and the indicator station,
- determine if significant spatial differences in ^{90}Sr concentrations were present,
- to assess whether or not ^{90}Sr concentrations in the bones and flesh of fish signify heightened risk either to aquatic life in the Hudson River, and
- provide information for an independent assessment of potential public health impacts.

METHODS

Part of Entergy's REMP requirements is to conduct routine radiological surveillance using composite samples of edible tissues of fish two or more important commercial and/or recreational fish or invertebrate species. Possible target species include striped bass (*Morone saxatilis*), white perch (*Morone americana*), American eel (*Anguilla rostrata*), white catfish (*Ictalurus catus*) or channel catfish (*Ictalurus punctatus*), sunfishes including pumpkinseed (*Lepomis gibbosus*), bluegill (*L. macrochirus*) or redbreast sunfish (*L. auritus*), and blue crab (*Callinectes sapidus*). Sampling occurs in spring and fall of each year at two locations, i.e., in

the vicinity of Indian Point Nuclear Power Plant (approximately river mile 42) and the vicinity of Roseton Generating Station (the traditional reference station at approximate river mile 65). One composite sample of each species is collected at each location and is analyzed for a host of radionuclides.

Sampling is conducted by Normandeau Associates, Inc. under contract with Entergy, and samples consist of by-catch of fish or blue crabs taken as a consequence of sampling for other purposes. All samples were collected in June 2007 and were frozen (– 20º C) in a locked freezer until prepared for shipment for chemical analyses. The prepared sample mass is a minimum of 1600 g and a maximum of 2000 g. This sample mass is split three ways. The first split of 1000 g went to Entergy's contract laboratory, AREVA, Inc. The second split of 300 to 500 g went to the Nuclear Regulatory Commission for analysis at the Oak Ridge Institute for Science and Education (ORISE). The third split (300 to 500 g) was sent to the NYSDOH Wadsworth Center for Labs and Research. Collection records and chain of custody are maintained for all samples (Appendix A).

The one-time design modifications for the 2007 effort included: the addition of carp (*Cyprinus carpio*) – a benthic feeder – to the target species list; adding ^{90}Sr to the list of radionuclide analytes; analysis of fish bone or crab carapace; and sampling fish at a third location, i.e., the Catskill Region between river miles 107 and 125 (Figure 1). This upstream location assures appropriate separation of fish populations that are resident to the river, and, consequently, assures isolation of resident fish populations from the potential influence of the Indian Point Nuclear Power Plant.

Normandeau Associates, Inc. prepared the samples of edible portions of fish and blue crabs. Skinless filets were excised from each specimen, composites by species were made, and each composite was thoroughly ground and homogenized. Subsamples were developed for each laboratory. These were double packaged in food grade plastic bags, labeled, frozen, and shipped to each participating laboratory.

The remaining carcasses of the fish and blue crabs were provided to the NYSDEC's laboratory at the Hale Creek Field Station, Gloversville, NY where they were prepared for radiological analyses by the NYSDOH Wadsworth Center for Labs and Research. In addition to the required species, samples of other fish species were provided to Hale Creek including yellow perch (*Perca flavescens*), rock bass (*Ambloplites rupestris),* smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and brown bullhead (*Ameiurus nebulosus*).

Preparation of bone and carapace samples was conducted in several steps. First, the samples were cleaned to remove as much muscle, skin, scales or other tissues as possible. The resulting bone samples were placed in a fume hood and air dried for 48 hours, then each sample was individually bagged, labeled and stored in a locked freezer until they were sent for further cleaning by dermestid beetles maintained by the New York State Museum at their Rensselaer Technology Park offices in Troy, NY. Each bone sample was maintained in an individual labeled sample container while undergoing dermestid cleaning. Following this process, each sample was frozen to kill the dermestids, rethawed, and the frass (dermestid larval carcasses and

fecal material) was removed from the bone. Finally, the skeletal and cranial bones (fins were excluded) were placed in food grade plastic bags, labeled and submitted to the NYSDOH Wadsworth Center for Labs and Research. Continuing chain of custody was maintained throughout the process (Appendix B).

Analysis of radionuclides were conducted by NYSDOH using two methods:

- ^{90}Sr analyses of fish bone were conducted by USEPA Method 905.0 (Krieger and Whittaker 1980b). Steps in this method include isolation of strontium, measurement of total strontium, hold the strontium for decay to allow time for the ingrowth of the yttrium-90 daughter, isolate and measure yttrium-90.

- Common indicator radionuclides (^{134}Cs, ^{137}Cs, ^{60}Co, and ^{40}K) were analyzed using USEPA Method 901.1 (Krieger and Whittaker 1980a).

Concentrations reported in Tables are the value for the sample ± the analytical standard error. For example, a value of 8 ± 2 pCi/kg would mean the best estimate concentration is 8 pCi/kg although the concentration may be as little as 6 pCi/kg or as much as 10 pCi/kg.

Statistical tests for spatial differences in concentrations employed the Kruskal-Wallis test when there were three comparisons. The Mann-Whitney test was used when there were only two comparisons (Conover 1980). These non-parametric tests were chosen because of their ability to reduce the influence of outlier data. A difference was considered significant when the probability was less than 0.05 ($P < 0.05$).

RESULTS

Edible Tissue Samples

^{90}Sr was detected in only one sample of edible tissues, i.e., 8 ± 3 pCi/kg in blue crab taken from the vicinity of the Indian Point facility. Detection limits ranged between 3 and 6 pCi/kg (Table 2). Only the determinations made by the NYSDOH Wadsworth Center for Labs and Research are reported since their analytical methods were the most sensitive of the three laboratories conducting the analyses. No detectable radionuclides were reported by the other two laboratories.

Bone and Carapace Samples

^{90}Sr concentrations in bone of fish or the carapace of blue crabs are shown in Table 3. ^{90}Sr concentrations are relatively consistent among all fish species, including striped bass, within locations. Mean and standard deviation concentrations for all fish at the three locations were:

Location	n	^{90}Sr Concentration (pCi/kg)
Indian Point	10	199 ± 58
Roseton	10	222 ± 67
Catskill	10	271 ± 69

The single blue crab sample, taken from the Roseton area, had 760 pCi/kg of ^{90}Sr in the carapace. This is the highest ^{90}Sr concentration reported, and twice the highest fish concentration of 360 pCi/kg in yellow perch from the Catskill area.

Among other radionuclides analyzed, ^{134}Cs, ^{137}Cs, ^{58}Co and ^{60}Co were not detected in bone or carapace of any sample. Detection limits ranged from 0.2 to 80 pCi/kg for ^{134}Cs, ^{137}Cs and ^{60}Co, and an order of magnitude greater for ^{58}Co. ^{40}K was present in nearly all samples within a limited range of concentrations and with mean and standard concentrations by area in fish as follows:

Location	n	^{40}K Concentration (pCi/kg)
Indian Point	9	2840 ± 678
Roseton	10	3540 ± 978
Catskill	10	2740 ± 614

Table 4 presents concentrations of other radionuclides that were detected in bones of fish.

DISCUSSION

^{90}Sr in bone versus edible tissues

Whicker *et al*. (1990) compared ^{90}Sr concentrations in bone and edible flesh of fish taken from a cooling water pond at the USDOE Savannah River nuclear power plant. Similar comparisons were made for fish in waters downstream of the Nuclear Fuels Services Inc. nuclear waste treatment plant in West Valley, NY, and in Lake Ontario (NYSDEC 1971) (Table 5). In these studies the ratio of ^{90}Sr in bone to that in edible fish tissue (^{90}Sr bone:flesh ratio) ranged from less than one to 1198. The highest value is considered an outlier. The mean ^{90}Sr bone:flesh ratio, excluding the outlier, was about 35. (The mean must be viewed with caution since the West Valley study did not indicate whether the ^{90}Sr quantification method was the same as that used in the Savannah River study; wet weight versus dry mass in flesh, or original mass versus ash weight of bone. If the methods used are not the same the ratios may not be comparable.) If it is assumed that the two studies are comparable, and we apply this ratio to bone in the present study, the ^{90}Sr concentration in edible tissues would very near or below the detection limit. This tends to confirm the reported lack of detection of ^{90}Sr in edible flesh of fish from the lower Hudson River (Tables 2 and 5) in 2007.

Spatial differences

There were no significant differences (P = 0.096) in ^{90}Sr concentrations between the three locations for resident fish. Looking at reference stations only, there was no significant difference in ^{90}Sr at Catskill and Roseton. Inclusion of striped bass, a migratory fish species, would not have changed the overall conclusion because of the similarity of ^{90}Sr concentrations.

In contrast, ^{40}K was statistically greater (P = 0.018) at the Roseton station than at either Indian Point or Catskill (which were equivalent) despite the small difference in average ^{40}K concentrations. Inclusion of striped bass would not have changed the finding. ^{40}K is a naturally occurring "primordial" radionuclide (Copplestone *et al*. 2001) which is expected to be found at these concentrations in fish and is not associated with nuclear waste for power production or fallout from weapons testing (Eisler 1994). The differing levels, albeit they are small differences, have no known significance.

Lastly, there were no differences between stations for ^{224}Ra. There were insufficient data to assess spatial differences for other radionuclides.

Relationship to criteria

The U.S. Department of Energy (USDOE) developed ecological standards for the protection of terrestrial animals, terrestrial plants, and aquatic animals based on published literature reviews of the effects of ionizing radiation on biota (NCRP 1991; IAEA 1992; UNSCEAR 1996). The standard for the protection of aquatic animals is:

> "The absorbed dose to aquatic animals should not exceed 1 rad/day (10 mGy/day or 400 μGy/hr[1]) from exposure to radiation or radioactive material releases into the aquatic environment."

This dose is specified in DOE Order 5400.5 (USDOE 2002). This standard is designed to protect populations of aquatic organisms, not individuals. At absorbed dose rates below the standard, populations will be maintained but some individual animals can suffer adverse impacts.

USDOE (2002) provides dose conversion factors (DCF) which can be used to estimate the absorbed dose from the internal abundance/activity of a radionuclide accumulated by an aquatic organism. The DCF calculations are conservative in that they assume all of the energies of radioactive decay are retained in the tissue of the organism, and that the radionuclides were presumed to be homogenously distributed in tissue. They are expressed in units of Rad/day per pCi/g wet weight. Using the DCFs it is possible to estimate the absorbed dose from the internal radionuclide concentration. Additional conversions were employed to express the total dose in

[1] A Gray (Gy) is a standard international unit of absorbed dose of radiation adopted by the International Commission on Radiological Protection in 1977. 1 Rad = 0.01 Gy; conversely, 1 Gy = 100 Rads.

the Standard International (SI) units for chronic absorbed dose rates of μGy/hr. USDOE (2002) did not report DCFs for ^{224}Ra and ^{40}K.

The highest tissue/bone concentrations of radionuclides listed in Tables 1 – 4 are the upper bound concentrations (i.e., measured concentration plus the 95% confidence interval) of 809 pCi/kg of ^{90}Sr from blue crab carapace (Table 3), 370 pCi/kg of ^{238}U and 320 pCi/kg ^{232}Th measured in the bones of striped bass (Table 4). All three samples were collected from the Roseton Generating Station (River Mile 65). Using the DCFs from (USDOE 2002), these concentrations can be converted to an internal dose rates:

> 809 pCi/kg of ^{90}Sr would result in an estimated internal dose rate of 0.02 μGy/hr;
> 370 pCi/kg of ^{238}U would result in an estimated internal dose rate of 0.7 μGy/hr; and
> 320 pCi/kg of ^{232}Th would result in an estimated internal dose rate of 5.5 μGy/hr.

All of these dose rates range from about two to five orders of magnitude below the USDOE (2002) standard of protection for aquatic animals. While the highest internal dose to striped bass from a single radionuclide was from ^{232}Th. However, to estimate the total internal dose, the internal doses from all radionuclides present must be summed. Using the upper bound concentrations for ^{226}Ra, ^{232}Th, and ^{238}U with the DCFs from (USDOE 2002), the total internal dose to striped bass collected at the Roseton Power Generating Station can be estimated to be 8.4 μGy/hr. A DCF for ^{224}Ra is not available, probably because this is a short-lived radionuclide with a half-life of only 3.7 days (Eisler 1994). ^{224}Ra disintegrates rapidly through a series of seven daughter radionuclides to the stable nuclide ^{208}Pb with a total half-life for the whole series of about 65 minutes (Nebergall *et al*. 1968).

The standards of protection published in USDOE (2002) were derived from a qualitative evaluation of radiological effects data. The European Union (EU) took a more quantitative approach to deriving ecological standards. EU assembled a large database of the impacts of ionizing radiation to biota and evaluated the studies to identify critical toxicity endpoints. Once the critical toxicity endpoints were determined, they were used with standard EU risk assessment protocols to derive a chronic Predicted-No-Effect-Dose Rates (PNEDR) screening value of 10 μGy/hr for freshwater, terrestrial, and marine/estuarine ecosystems (Garnier-Laplace and Gilbin 2006). The total absorbed dose from the internal concentration of ^{232}Th, ^{226}Ra, and ^{238}U in striped bass is less than the chronic screening no effects dose rate derived by the EU.

The internal dose rate conversion factors from USDOE (2002) are conservative, but they do not take into account absorbed doses received from external sources, such as radionuclides in the water and sediment. There is no way to estimate those dose rates without measurements.

USDOE (2002) provides a method for estimating the total absorbed dose to biota from both external and internal sources. This approach uses Biota Concentration Guides (BCG)s which are concentrations of 23 different radionuclides in water, soil, and sediment. If the BCG concentrations are not exceeded, the total absorbed dose will not exceed the USDOE (2002) standards of protection. In order to utilize this method, simultaneous samples of water and sediment must be collected and analyzed in the immediate vicinity of suspected unregulated releases of radioactive materials into the Hudson River.

No excursions above ecological standards for the protection of aquatic animals appear to have occurred. However, the current monitoring effort does not allow for the full assessment of risks to aquatic animals. To fully evaluate the risks, the concentrations of the full range of 23 radionuclides listed in USDOE (2002) in both water and sediment samples collected from the same location simultaneously should be sampled. This would allow for the full use of the "Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" as described in USDOE (2002) to be employed to evaluate and assess risks to aquatic biota.

The 23 radionuclides which should be sampled include: ^{241}Am, ^{144}Ce, ^{135}Cs, ^{137}Cs, ^{60}Co, ^{154}Eu, ^{155}Eu, ^{3}H, ^{129}I, ^{131}I, ^{239}Pu, ^{226}Ra, ^{228}Ra, ^{125}Sb, ^{90}Sr, ^{99}Tc, ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{238}U, ^{65}Zn, and ^{95}Zr.

CONCLUSIONS

Two conclusions can be made.

1. There are no apparent excursions above criteria for the protection of biota based on the radionuclide data available. The levels of radionuclides - including ^{90}Sr – were two to five orders of magnitude lower than criteria established for protection of freshwater ecosystems.

2. There were no spatial differences in concentrations of ^{90}Sr and ^{224}Ra in resident fish from the three locations sampled in the lower Hudson River (i.e., Indian Point Nuclear Power Plant, and the reference sites at the Roseton Generating Station and at Catskill). In contrast, ^{40}K levels were somewhat greater in the vicinity of Roseton Generating Station, but the differing concentrations have no known significance.

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Table 1: ^{90}Sr concentrations in edible tissues of fish taken from the lower Hudson River in 2006.

Location	Species	^{90}Sr concentration (pCi/kg wet weight)	
		Measured detection limit (DL)	Sample[1]
Indian Point Nuclear Power Plant (indicator site)	Striped bass	8.5	<DL
	Blue crab	5.7	<DL
	American eel	7.1	<DL
	Catfish	6.4	<DL
	Sunfish	15	<DL
	White perch	9.0	18.8
Roseton Generating Station (reference site)	Striped bass	4.2	<DL
	Blue crab	11.0	13.6
	American eel	4.3	<DL
	Catfish	7.6	<DL
	Sunfish	9.6	17.1
	White perch	8.7	24.5

[1] Analyses by Entergy Nuclear Operations, Inc. contract laboratory, i.e., AREVA, Inc.

Table 2: ^{90}Sr and other radionuclide concentrations in edible tissues of fish and blue crab from three locations on the lower Hudson River in June 2007[1].

Location	Species	No. in sample	Concentration (pCi/kg wet weight)[2]					
			^{90}Sr	^{134}Cs	^{137}Cs	^{58}Co	^{60}Co	^{40}K
Indian Point Nuclear Power Plant (RM 42)[3]	Blue crab	62	8 ± 3	<3	<3	<3	<4	2510 ± 180
	Striped bass	7	<4	<1.9	<2	<2	<2	2400 ± 150
	White perch	57	<3	<2	<3	<3	<3	2750 ± 170
	Catfish	15	<4	<1.9	<2	<3	<2	2580 ± 150
	American eel	19	<4	<2	<3	<3	<2	2320 ± 150
	Carp	2	<5	<1.7	<2	<3	<1.8	2590 ± 150
	Sunfishes	79	<6	<2	<2	<3	<2	2660 ± 170
Roseton Generating Station (RM 65)	Striped bass	1	NA[4]	NA	NA	NA	NA	NA
	White perch	116	<5	<2	<3	<3	<2	2440 ± 160
	Catfish	45	<3	<1.8	<2	<2	<1.8	2620 ± 150
	American eel	15	<4	<2	<3	<3	<2	2490 ± 160
	Carp	4	<4	<1.7	<1.9	<3	<1.8	2480 ± 150
	Sunfishes	30	<3	<3	<3	<3	<3	2590 ± 170
Catskill Region (RM 107 – 125)	White perch	108	<4	<2	6 ± 3	<3	<2	2390 ± 160
	Catfish	18	<3	<1.9	9 ± 3	<3	<1.9	2640 ± 160
	American eel	15	<4	<2	<3	<3	<2	2000 ± 140
	Carp	2	<4	<2	<2	<3	<2	2450 ± 150
	Sunfishes	18	<4	<2	<3	<3	<2	2620 ± 170

[1] All analyses by the New York State Department of Health's Wadsworth Center for Labs and Research.

[2] A less than (<) value indicates the concentration is less than the specified detection limit for the sample.

[3] RM = Approximate location in river mile(s).

[4] NA = Not analyzed. Analyses by the Nuclear Regulatory Commission's laboratory, Oak Ridge Institute for Science and Education [ORISE], reported ^{90}Sr at <4 pCi/kg, and ^{134}Cs, ^{137}Cs, ^{58}Co and ^{60}Co as <10 pCi/kg each; no analyses were conducted of ^{40}K.

Table 3: ^{90}Sr and other radionuclide concentrations in bone of fish and carapace of blue crab from three locations on the lower Hudson River in June 2007.

Location	Species	No. in sample	Concentration (pCi/kg wet weight)[1]					
			^{90}Sr	^{134}Cs	^{137}Cs	^{58}Co	^{60}Co	^{40}K
Indian Point Nuclear Power Plant (River Mile 42)	Striped bass	7	96 ± 89	<4	<4	<21	<4	2710 ± 190
	White perch	28	190 ± 34	<5	<4	<21	<3	2240 ± 170
	Yellow perch	27	240 ± 50	<7	<6	<30	<6	2600 ± 200
	Brown bullhead	8	220 ± 62	<7	<6	<30	<6	4100 ± 300
	Channel catfish	1	230 ± 48	nd	nd	nd	nd	nd
	White catfish	7	160 ± 46	<5	<4	<20	<5	3000 ± 200
	American eel	21	150 ± 31	<9	<9	<41	<8	3200 ± 300
	Carp	2	290 ± 62	<3	<3	<17	<3	1670 ± 130
	Pumpkinseed	5	250 ± 58	<20	<16	<100	<19	2800 ± 400
	Sunfishes	35	160 ± 32	<7	<6	<30	<6	3200 ± 300
Roseton Generating Station (River Mile 65)	Blue crab	6	760 ± 49	<11	<9	<90	<9	3800 ± 300
	Striped bass	1	140 ± 57	<7	<5	<60	<6	2030 ± 160
	White perch	55	270 ± 62	<9	<7	<80	<8	3100 ± 300
	White perch	70	270 ± 39	<8	<8	<70	<8	3000 ± 300
	Brown bullhead	6	250 ± 72	<5	<4	<40	<4	3110 ± 180
	Brown bullhead	33	220 ± 63	<6	<6	<60	<5	3400 ± 300
	Channel catfish	5	130 ± 79	<6	<6	<60	<6	4900 ± 300
	American eel	15	140 ± 78	<10	<9	<90	<10	3500 ± 300
	Perch	9	260 ± 42	<12	<10	<100	<10	3100 ± 300
	Sunfishes	26	210 ± 66	<10	<10	<90	<8	3900 ± 400
	Rock bass	1	330 ± 310	<80	<60	<600	<80	5400 ± 100
Catskill Region (River Miles 107 – 125)	White perch	74	310± 46	<8	<6	<70	<6	2300 ± 200
	Brown bullhead	6	300 ± 50	<10	<7	<90	<8	2700 ± 200
	Channel catfish	11	220 ± 83	<4	<4	<60	<4	2800 ± 200
	American eel	16	120 ± 77	<11	<8	<90	<9	3300 ± 300
	Sunfishes	23	290 ± 95	<10	<8	<90	<10	4000 ± 400
	Carp	2	260 ± 31	<4	<4	<40	<3	2050 ± 180
	Largemouth bass	6	220 ± 38	<3	<2	<40	<2	2530 ± 130
	Smallmouth bass	2	330 ± 45	<10	<13	<170	<15	2800 ± 300
	Black crappie	1	300 ± 120	<30	<20	<200	<20	3000 ± 400
	Perch	17	360 ± 41	<12	<9	<140	<10	1900 ± 200

[1] A less than (<) value indicates the concentration is less than the specified detection limit for the sample. nd = not determined.

Table 4: Radionuclide concentrations measured in bone of fish from three locations on the lower Hudson River in June 2007.

Location	Species	No. in sample	Concentration (pCi/kg wet weight)			
			^{224}Ra	^{226}Ra	^{232}Th	^{238}U
Indian Point Nuclear Power Plant (River Mile 42)	Striped bass	7	26 ± 9.0	21 ± 9.0	47 ± 15	
	White perch	28	33 ± 9.0	25 ± 9.0		
	Yellow perch	27	31 ± 13	30 ± 14		
	Brown bullhead	8	23 ± 10	22 ± 12		
	White catfish	7	17 ± 8.0			
Roseton Generating Station (River Mile 65)	Striped bass	1	105 ± 14	153 ± 19	290 ± 30	290 ± 80
	White perch	55	31 ± 17	28 ± 17		
	White perch	70	47 ± 16			
	Brown bullhead	33	24 ± 11		50 ± 20	
	Perch	9	59 ± 17	34 ± 18		
Catskill Region (River Miles 107 – 125)	White perch	74	40 ± 20			
	Brown bullhead	6			60 ± 20	
	Sunfishes	23	48 ± 18			
	Carp	2	16 ± 7.0	19 ± 9.0		
	Perch	17	21 ± 18	<20	50 ± 30	

Table 5: Comparison of ^{90}Sr concentrations in bone and edible flesh of fish.

State/Site	Location	Species	n	Concentration		Ratio bone:flesh	Reference
				Bone	Edible flesh		
South Carolina/ USDOE Savannah River Plant	Pond B	Largemouth bass	28	~ 14.5 Bq/g ash	0.47 Bq/g dm[1]	31	Whicker *et al.* 1990
		Yellow bullhead	28	~ 13	0.086	151	
New York/ Nuclear Fuel Services, Inc.	Cattaraugus Cr.						NYSDEC 1971
	- Rt. 16 bridge	Suckers	nr[2]	228 pCi/kg	82 pCi/kg	2.8	
	- Springville Dam	Suckers	nr	10491	1679	6.2	
		Suckers	nr	31000	500	62	
	- mouth (Sunset Bay)	Rainbow trout	nr	127	3	42	
		Carp	nr	606	23	26	
		Suckers	nr	9587	8	1198	
		Salmon	nr	173	246	0.7	
New York/ Nuclear Fuel Services, Inc.	Buttermilk Cr.	Trout	nr	320,000 pCi/kg	5400 pCi/kg	59	NYSDEC 1971
	- at Bond Road	Suckers	nr	620,000	12,000	52	
		Suckers	nr	89,537	14,456	6.2	
New York	Lake Ontario	Bass	nr	1410 pCi/kg	< DL	nc[4]	NYSDEC 1971
	- at Brockwood	Bluegill	nr	312	62 pCi/kg	5.0	
	(Wayne County)	Bullhead	nr	330	24	14	
		Sunfish	nr	89	17	5.3	
		Perch	nr	3516	40	88	
		Sucker	nr	497	15	33	
		Black crappie	nr	671	< DL[3]	nc	
		Perch	nr	271	29	9.3	
		Largemouth bass	nr	408	10	41	
		Rock bass	nr	270	25	11	
		Silver bass	nr	485	13	37	
		Carp	nr	898	15	60	
New York/Indian Point Nuclear Power Plant	Hudson River	5 species	5	204	< 6	≥ 34	This study
New York/Roseton Generating Station	Hudson River	4 species	5	204	< 5	≥ 41	This study
New York	Hudson River - at Catskill	5 species	5	240	< 4	≥ 60	This study

[1] dm = dry mass. [2] nr = Not reported. [3] DL = Detection limit. [4] nc = Not calculated; detection limit not reported.

Figure 1: Sampling locations for the project "^{90}Sr Analysis of Bone Taken from Hudson River Fish"

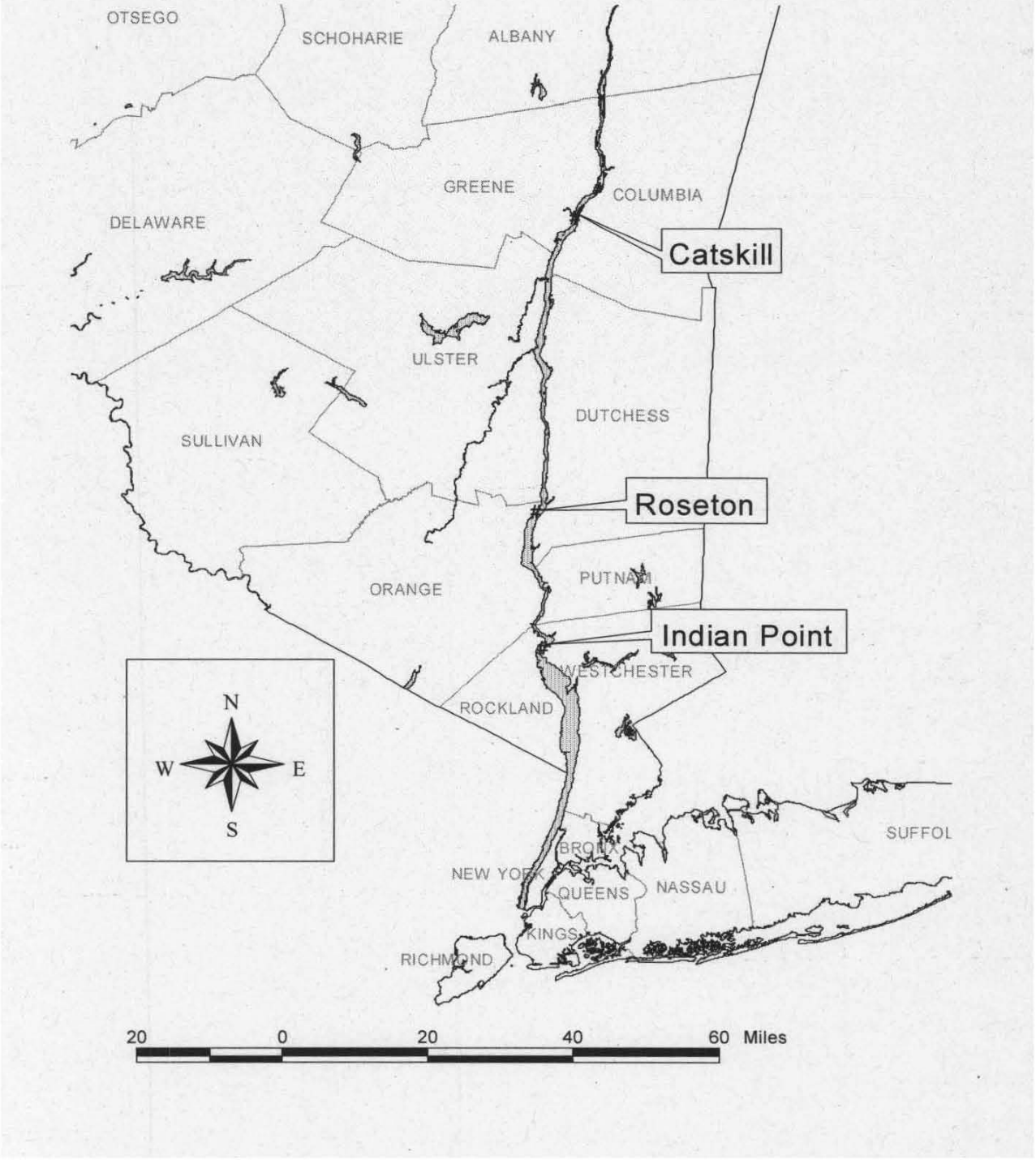

Figure 1

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
Bureau of Habitat, 5th Floor
625 Broadway, Albany, New York 12233-4756
Phone: (518) 402-8924 • **FAX:** (518) 402-8925
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

original to go w/ samples

I, Lawrence C. Skinner of the NYS Department of Environmental Conservation, have received from Joseph Bopp of the NYS Museum, on 11 day of December, 2007 the following samples of fish bones collected for Entergy Inc. for radionuclide surveillance of the Indian Point nuclear power plant. A copy of the related chain of custody for the samples is appended.

List of samples Entergy Region 4

07-0026-H	White catfish	07-0031-H	Brown bullhead
07-0027-H	Pumpkinseed	07-0032-H	Carp
07-0028-H	Channel catfish	07-0033-H	White perch
07-0029-H	Yellow perch	07-0034-H	Striped bass
07-0030-H	Sunfishes	07-0035-H	American eels

RECIPIENT (PRINT NAME) Lawrence C. Skinner	TIME AND DATE 1540 12/11/07	PURPOSE OF TRANSFER Sample debugging + transfer to DOH
SIGNATURE Lawrence C Skinner	UNIT Bur. of Habitat	
RECIPIENT (PRINT NAME) Traci A Meria	TIME AND DATE 12/14/07 13:30	PURPOSE OF TRANSFER analysis
SIGNATURE	UNIT DEDP LINC	
RECIPIENT (PRINT NAME)	TIME AND DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
LOGGED IN BY (PRINT NAME)	TIME AND DATE	ACCESSION NUMBERS
SIGNATURE	UNIT	

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
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625 Broadway, Albany, New York 12233-4756
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Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

CHAIN OF CUSTODY

I, Lawrence C. Skinner of the NYS Department of Environmental Conservation, have received from Joseph Bopp of the NYS Museum, on 8th day of February, 2008 the following samples of fish bones collected for Entergy Inc. for radionuclide surveillance of the Indian Point nuclear power plant. A copy of the related chain of custody for the samples is appended.

List of samples

07-0004-H	White perch	07-0016-H	American eel
07-0005-H	Blue crab	07-0017-H	Sunfish
07-0006-H	Yellow perch	07-0018-H	White perch
07-0007-H	White perch	07-0019-H	Brown bullhead
07-0008-H	Rock bass	07-0020-H	Smallmouth bass
07-0009-H	Sunfish	07-0021-H	Black crappie
07-0010-H	Channel catfish	07-0022-H	Yellow perch
07-0011-H	Brown bullhead	07-0023-H	Carp
07-0013-H	Striped bass	07-0024-H	Channel catfish
07-0014-H	Brown bullhead	07-0025-H	Largemouth bass
07-0015-H	American eel		

RECIPIENT (PRINT NAME) Lawrence C. Skinner	TIME AND DATE 2/8/08 @ 1520	PURPOSE OF TRANSFER Debagging and transfer to DOH
SIGNATURE Lawrence C. Skinner	UNIT DEC - Habitat	
RECIPIENT (PRINT NAME) Traci A. Menia	TIME AND DATE 02/15/08 @ 11:00	PURPOSE OF TRANSFER chemical analysis
SIGNATURE T A M	UNIT DOH - nuclear chem.	
RECIPIENT (PRINT NAME)	TIME AND DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
LOGGED IN BY (PRINT NAME)	TIME AND DATE	ACCESSION NUMBERS
SIGNATURE	UNIT	

Received 11/2/07 By [signature]
NYSM Fish Lab 145 Jordan Rd Troy NY 12180

LAB #	TAG #	SPECIES	SAMPLE DATE	LOCATION	PROGRAM	NUMBER OF FISH OR CRABS
07-0004-H	07-0004-H	WP	2007	ENTERGY REG. 7	ENTERGY-2007	55
07-0005-H	07-0005-H	BCRAB	2007	ENTERGY REG. 7	ENTERGY-2007	6
07-0006-H	07-0006-H	PERCH	2007	ENTERGY REG. 7	ENTERGY-2007	9
07-0007-H	07-0007-H	WP	2007	ENTERGY REG. 7	ENTERGY-2007	70
07-0008-H	07-0008-H	RB	2007	ENTERGY REG. 7	ENTERGY-2007	1
07-0009-H	07-0009-H	SUN	2007	ENTERGY REG. 7	ENTERGY-2007	26
07-0010-H	07-0010-H	CHC	2007	ENTERGY REG. 7	ENTERGY-2007	5
07-0011-H	07-0011-H	BB	2007	ENTERGY REG. 7	ENTERGY-2007	33
07-0012-H	07-0012-H	CARP	2007	ENTERGY REG. 7	ENTERGY-2007	4
07-0013-H	07-0013-H	STB	2007	ENTERGY REG. 7	ENTERGY-2007	1
07-0014-H	07-0014-H	BB	2007	ENTERGY REG. 7	ENTERGY-2007	6
07-0015-H	07-0015-H	AMEL	2007	ENTERGY REG. 7	ENTERGY-2007	15
07-0016-H	07-0016-H	AMEL	2007	ENTERGY REG.11	ENTERGY-2007	16
07-0017-H	07-0017-H	SUN	2007	ENTERGY REG.11	ENTERGY-2007	23
07-0018-H	07-0018-H	WP	2007	ENTERGY REG.11	ENTERGY-2007	74
07-0019-H	07-0019-H	BB	2007	ENTERGY REG.11	ENTERGY-2007	6
07-0020-H	07-0020-H	SMB	2007	ENTERGY REG.11	ENTERGY-2007	2
07-0021-H	07-0021-H	BLC	2007	ENTERGY REG.11	ENTERGY-2007	1
07-0022-H	07-0022-H	PERCH	2007	ENTERGY REG.11	ENTERGY-2007	17
07-0023-H	07-0023-H	CARP	2007	ENTERGY REG.11	ENTERGY-2007	2
07-0024-H	07-0024-H	CHC	2007	ENTERGY REG.11	ENTERGY-2007	11
07-0025-H	07-0025-H	LMB	2007	ENTERGY REG.11	ENTERGY-2007	6
07-0026-H	07-0026-H	WC	2007	ENTERGY REG.4	ENTERGY-2007	7
07-0027-H	07-0027-H	PKSD	2007	ENTERGY REG.4	ENTERGY-2007	5
07-0028-H	07-0028-H	CHC	2007	ENTERGY REG.4	ENTERGY-2007	1
07-0029-H	07-0029-H	PERCH	2007	ENTERGY REG.4	ENTERGY-2007	27
07-0030-H	07-0030-H	SUN	2007	ENTERGY REG.4	ENTERGY-2007	35
07-0031-H	07-0031-H	BB	2007	ENTERGY REG.4	ENTERGY-2007	8
07-0032-H	07-0032-H	CARP	2007	ENTERGY REG.4	ENTERGY-2007	2
07-0033-H	07-0033-H	WP	2007	ENTERGY REG.4	ENTERGY-2007	28
07-0034-H	07-0034-H	STB	2007	ENTERGY REG.4	ENTERGY-2007	7
07-0035-H	07-0035-H	AMEL	2007	ENTERGY REG.4	ENTERGY-2007	21

n = 32 records

Each record is a bag containing dried fish or dried crabs.

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ENVIRONMENTAL CONSULTANTS
www.normandeau.com (603) 472-5191

Chain of Custody Form

Project Name: ENTERGY INDIAN POINT REMP
Project Number: 21020.002
Originating Contact: JOAN BLAN
Originator Location: WEST HAVERSTRAW, N.Y.
Final Destination: INDIAN POINT ENERGY CENTER
Sampler(s): CHRIS BURNETT, LAWSON UPCHURCH

Page 1 of 6
Method of Shipment:

Sample No.	Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Presv. FROZEN	Parameters	Comments Below:
1	PERCH	6/6/07	1519	1	ZIPLOCK BAG	✓		✓		REG. 4
2	BLUE CRAB	6/6/07	1544	1		✓		✓		REG. 4
2●	PERCH	6/6/07	1544	1		✓		✓		REG. 4
3	PERCH	6/7/07	0930	1		✓		✓		REG. 7
3	BROWN BULLHEAD	6/7/07	0930	1		✓		✓		REG. 7
3	CARP	6/7/07	0930	1		✓		✓		REG. 7
4	BROWN BULLHEAD	6/7/07	0959	1		✓		✓		REG. 7
	CHANNEL CAT	6/7/07		1		✓		✓		REG. 7
	EEL			1		✓		✓		REG. 7
	PERCH			1		✓		✓		REG. 7
4	CARP	6/7/07	0959	1		✓		✓		REG. 7-2 BAGS
5	PERCH	6/7/07	1100	1		✓		✓		REG. 7
5	BROWN BULLHEAD	6/7/07	1100	1		✓		✓		REG. 7
5	EEL	6/7/07	1100	1		✓		✓		REG. 7
6	EEL	6/7/07	1201	1		✓		✓		REG. 7
6	PERCH	6/7/07	1201	1		✓		✓		REG. 7
7	CARP	6/7/07	1230	1		✓		✓		REG. 7
8	CHANNEL CAT	6/7/07	1348	1	ZIPLOCK BAG	✓		✓		REG. 7
			Total	18						

Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)
Joan Blan	Joseph Stube	Joseph Stube	John Finn	Tim Preddice	Lawrence C. Skinner
Printed Name: JOAN BLAN	Printed Name: Joseph Stube	Printed Name: Joseph Stube	Printed Name: JOHN FINN	Printed Name: Tim Preddice	Printed Name: Lawrence C. Skinner
Date: 7-11-07	Date: 7/12/07	Date: 7/18/07	Date: 7/19/07 12:00pm	Date: 10/17/07 page 1 of 6	Date: 10/17/07 1115 59, 1 of 6

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Chain of Custody Form

Project Name: ENTERGY INDIAN POINT REMP
Project Number: 21020.002
Originating Contact: JOAN BLAN
Originator Location: WEST HAVERSTRAW, N.Y.
Final Destination: INDIAN POINT ENERGY CENTER
Sampler(s): CHRIS BURNETT, LAWSON UPCHURCH

Presv.: FROZEN

Parameters

Page 2 of 6

Method of Shipment:

Sample No.	Identification	Collection Date	Time	Containers No.	Type	Grab.	Comp.	Comments Below:
8	BROWN BULLHEAD	6/7/07	1348	1	ZIP LOCK BAG	✓		REG. 7
8	PERCH	6/7/07	1348	1		✓		REG. 7
9	PERCH	6/7/07	1420	1		✓		REG. 7
9	BROWN BULLHEAD	6/7/07	1420	1		✓		REG. 7
10	STRIPED BASS	6/7/07	1543	1		✓		REG. 4
11	PERCH	6/8/07	0822	1		✓		REG. 4
11	WHITE CATFISH	6/8/07	0822	1		✓		REG. 4
11	CARP	6/8/07	0822	1		✓		REG. 4
12	PERCH	6/8/07	0851	1		✓		REG. 4
13	CHANNEL CAT	6/8/07	0916	1		✓		REG. 4
13	PERCH	6/8/07	0916	1		✓		REG. 4
13	STRIPED BASS	6/8/07	0916	1		✓		REG. 4
14	CHANNEL CAT	6/12/07	1230	1		✓		REG. 11
14	SUNFISH	6/12/07	1230	1		✓		REG. 11
15	BROWN BULLHEAD	6/12/07	1500	1		✓		REG. 11
15	PERCH	6/12/07	1500	1		✓		REG. 11
15	POMPKINSEED	6/12/07	1500	1		✓		REG. 11
15	BLACK CRAPPIE	6/12/07	1500	1	ZIP LOCK BAG	✓		REG. 11

Total 18

Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)
Joan Blan	Joseph Strube		John Finn		
Printed Name: JOAN BLAN	Printed Name: Joseph Strube	Printed Name:	Printed Name: JOHN FINN	Printed Name:	Printed Name:
Date: 7-11-07	Date: 7/12/07	Date:	Date: 7/19/07 12:00pm	Date:	Date:

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Final Destination: INDIAN POINT ENERGY CENTER
Sampler(s): CHRIS BURNETT, LAWSON LACHURCH

Method of Shipment:

Sample No.	Sample Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Presv. FROZEN	Parameters	Comments Below:
16	PERCH	6/13/07	1303	1	ZIPLOCK BAG	✓				REG. 7
16	SUNFISH			1		✓				REG. 7
16	BROWN BULLHEAD			1		✓				REG. 7
16	WHITE CATFISH		1303	1		✓				REG 7
17	EEL		1430	1		✓				REG. 4
18	BLUE CRAB	6/13/07	1438	1		✓				REG. 4
19	CARP	6/14/07	0730	1		✓				REG. 4
19	WHITE CATFISH	6/14/07	0730	1		✓				REG. 4
19	PERCH		0730	1		✓				REG. 4
20	BLUE CRAB		0745	1		✓				REG. 4
21	EEL		0756	1		✓				REG. 4
22	STRIPED BASS		0910	1		✓				REG. 7
23	EEL		0940	1		✓				REG. 7
24	SUNFISH	6/14/07	1006	1		✓				REG. 7
25	BROWN BULLHEAD	6/15/07	0824	1		✓				REG. 11
25	CHANNEL CATFISH			1		✓				REG. 11
25	EEL			1		✓				REG. 11
25	PERCH			1		✓				REG. 11
			Total	18						

Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)
Joan Blan	Joseph Struhe		John Finn		
Printed Name: JOAN BLAN	Printed Name: Joseph Struhe	Printed Name:	Printed Name: JOHN FINN	Printed Name:	Printed Name:
Date: 7-11-07	Date: 7/12/07	Date:	Date: 7/17/07 12:00 pm	Date:	Date:

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Chain of Custody Form

Project Name: ENTERGY INDIAN POINT REMP
Project Number: 21020.002
Originating Contact: JOAN BLAN
Originator Location: WEST HAVERSTRAW, N.Y.
Final Destination: INDIAN POINT ENERGY CENTER
Sampler(s): CHRIS BURNETT, LAWSON UPCHURCH

Page 4 of 6

Method of Shipment:

Sample No.	Sample Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Presv. FROZEN	Parameters	Comments Below:
26	CHANNEL CAT	6/15/07	0845	1	ZIP LOCK BAG	✓		✓		REG-11
26	CARP		0845	1		✓				REG-11
26	LARGEMOUTH BASS		0845	1		✓				REG-11
27	EEL		0902	1		✓				REG-11
28	BROWN BULLHEAD		0922	1		✓				REG-11
28	CHANNEL CAT		0922	1		✓				REG-11
29	WHITE PERCH		1030	1		✓				REG-11
29	~~CRAPPIE~~ SUNFISH		1030	1		✓				REG-11
29	BROWN BULLHEAD		1030	1		✓				REG-11
30	EEL	6/15/07	1104	1		✓				REG-11
31	BLUE CRAB	6/18/07	0800	1		✓				REG-4
32	SUNFISH	6/11/07	1522	1		✓				REG-4
33	BLUE CRAB	6/18/07	0950	1		✓				REG-4
33	WHITE CAT			1		✓				REG-4
33	PERCH			1		✓				REG-4
33	BROWN BULLHEAD			1		✓				REG-4
33	EEL			1		✓				REG-4
33	SUNFISH			1		✓				REG-4
			Total	18						

Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)
Joan Blan	Joseph Struble		John Finn		
Printed Name: JOAN BLAN	Printed Name: Joseph Struble	Printed Name:	Printed Name: JOHN FINN	Printed Name:	Printed Name:
Date: 7-11-07	Date: 7/12/07	Date:	Date: 7/19/07 12:00 PM	Date:	Date:

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Chain of Custody Form

Project Name: ENTERGY INDIAN POINT REMP
Project Number: 21020.002
Originating Contact: JOAN BLAN
Originator Location: WEST HAVERSTRAW, N.Y.
Final Destination: INDIAN POINT ENERGY CENTER
Sampler(s): CHRIS BURNETT, LAWSON OACHURCH

Presv.: FROZEN
Parameters
Page 5 of 6
Method of Shipment:

Sample No.	Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Comments Below:
34 V	ROCK BASS	6/18/07	1155	1	ZIPLOCK BAG	✓		REQ. 7
34 V	PERCH	↓	1155	1		✓		REQ. 7
34 V	BLUE CRAB	↓	1155	1		✓		REQ. 7
35 V	EEL	6/18/07	1230	1		✓		REQ. 7
36	PERCH	6/19/07	0730	1		✓		REQ. 4
36	BLUE CRAB	↓	0730	1		✓		REQ. 4
37	BLUE CRAB	↓	0740	1		✓		REQ. 4
38	BLUE CRAB	↓	0809	1		✓		REQ. 4
39 V	EEL	6/19/07	0815	1		✓		REQ. 4
40	CARP	6/19/07	1400	1		✓		REQ. 11
	LARGEMOUTH BASS	↓	↓	1		✓		REQ. 11
	SMALLMOUTH BASS	↓	↓	1		✓		REQ. 11
↓	PERCH	↓	↓	1		✓		REQ. 11
40	SUNFISH	↓	1400	1		✓		REQ. 11
41	CHANNEL CAT	6/19/07	1510	1		✓		REQ. 11
41	PERCH	↓	1510	1		✓		REQ. 11
41	SUNFISH	↓	1510	1		✓		REQ. 11
42	PERCH	6/19/07	1610	1	↓	✓		REQ. 11
			Total	18				

Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)
Joan Blan	Joseph Struhs		John Finn		
Printed Name: JOAN BLAN	Printed Name: Joseph Struhs	Printed Name:	Printed Name: JOHN FINN	Printed Name:	Printed Name:
Date: 7-11-07	Date: 7/12/07	Date:	Date: 7/19/07	Date:	Date:

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Chain of Custody Form

Project Name: ENTERGY INDIAN POINT REMP
Project Number: 21020.002
Originating Contact: JOAN BLAN
Originator Location: WEST HAVERSTRAW, N.Y.
Final Destination: INDIAN POINT ENERGY CENTER
Sampler(s): CHRIS BURNETT, LAWSON UPCHURCH

Page 6 of 6

Method of Shipment:

Sample No.	Sample Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Presv. FROZEN	Parameters	Comments Below:
42	SUNFISH	6/19/07	1610	1	2 GALLON ZIPLOCK BAG	✓		✓		REQ. 11
43	EEL		1331	1		✓				REQ. 7
	BLUE CRAB			1		✓				REQ. 7
	PERCH			1		✓				REQ. 7
43	SUNFISH		1331	1		✓				REQ. 7
44	EEL		1600	1		✓				REQ. 4
	PERCH			1		✓				REQ. 4
	BLUE CRAB			1		✓				REQ. 4
44	SUNFISH	6/19/07	1600	1		✓				REQ. 4
45	SUNFISH	6/20/07	1230	1		✓				LEQ. #7
45	PERCH	6/20/07	1230	1		✓				REQ. #7
46	SUNFISH	6/21/07	0800	1		✓				REQ. 4
47	Blue Crab	6/22/07	0830	1	ZIPLOCK BAG	✓		✓		Req. 7
				Total	13					

Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)	Relinquished by: (signature)	Received by: (signature)
Joan Blan	Joseph Struble		John Finn		
Printed Name: JOAN BLAN	Printed Name: Joseph Struble	Printed Name:	Printed Name: JOHN FINN	Printed Name:	Printed Name:
Date: 7-11-07	Date: 7/12/07	Date:	Date: 7/19/07	Date:	Date:

Chain of Custody Form.doc 12/8/06

NORMANDEAU ASSOCIATES
Environmental Consultants
600 Beach Road
West Haverstraw, NY 10993

(845) 947-0390
(845) 947-4057 (Fax)

Facsimile Transmittal

To: LARRY SKINNER **Fax #:** 518 402-8925

From: JOAN BLAN **Date:** 11-18-09

Re: 2007 REMP **Pages:** 4

CC: MIKE RICCI
DARA GRAY

NOTES

THE FOLLOWING PAGES REFLECT THE NUMBER OF FISH & CRAB MEASURED, WEIGHED AND PROCESSED BY THE BEDFORD LAB FOR SPRING REMP 2007.

REGION 4 INDIAN PT.

SAM.#	SPECIES	COUNT	SAM.#	SPECIES	COUNT
1	PERCH	16	36	CRAB	6
2	PERCH	1	37	CRAB	22
10	S. BASS	1	38	CRAB	4
11	PERCH	4	39	EEL	7
11	CATFISH	4	44	PERCH	12
11	CARP	1	44	SUNFISH	3
12	PERCH	1	44	EEL	1
13	PERCH	1	44	CRAB	2
13	CATFISH	1	46	SUNFISH	64
13	S. BASS	6			
17	EEL	5			
18	CRAB	6			
19	PERCH	1			
19	CATFISH	1			
19	CARP	1			
20	CRAB	9			
21	EEL	5			
31	CRAB	10			
32	SUNFISH	7			
33	CATFISH	9			
33	CRAB	3			
33	PERCH	18			
33	SUNFISH	5			
33	EEL	1			
36	PERCH	3			

REGION 7 POUGHKEEPSIE

SAM.#	SPECIES	COUNT
3	CATFISH	3
3	CARP	1
4	PERCH	87
4	EEL	2
4	CATFISH	24
4	CARP	2
5	EEL	3
5	CATFISH	3
6	PERCH	2
7	CARP	1
8	PERCH	1
8	CATFISH	2
9	CATFISH	8
16	SUNFISH	5
16	PERCH	20
16	CATFISH	5
22	S. BASS	1
23	EEL	6
24	SUNFISH	3
34	SUNFISH	1
34	PERCH	3
35	EEL	2
43	SUNFISH	2
43	PERCH	2

SAM.#	SPECIES	COUNT
43	EEL	2
45	SUNFISH	19
45	PERCH	1

REGION 11 CATSKILL

SAM.#	SPECIES	COUNT
14	CATFISH	3
15	PERCH	3
15	CATFISH	1
25	PERCH	2
25	EEL	2
25	CATFISH	4
26	SUNFISH	1
26	CATFISH	6
26	CARP	1
27	EEL	8
28	CATFISH	2
29	PERCH	20
29	CATFISH	1
30	EEL	5
40	SUNFISH	11
40	PERCH	66
40	CARP	1
41	PERCH	16
41	CATFISH	1
42	SUNFISH	6
42	PERCH	1