Green, Kimberly

From: Julie Crocker [Julie.Crocker@Noaa.Gov]
Sent: Thursday, September 22, 2011 5:06 PM
To: Stuyvenberg, Andrew
Subject: Fwd: RE: Schedule for final BO
Attachments: sr90fnlrprt.pdf; Julie_Crocker.vcf

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-------- Original Message --------
Subject:RE: Schedule for final BO
Date: Thu, 22 Sep 2011 14:09:31 -0400
From: Trach, William J <WTrach@goodwinprocter.com>
To: Julie Crocker <Julie.Crocker@Noaa.Gov>
CC: Zoli, Elise N <EZoli@goodwinprocter.com>

Hi Julie. Attached are the referenced documents. I apologize for the delay.

Thanks,

BJ

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From: Julie Crocker [mailto:Julie.Crocker@Noaa.Gov]
Sent: Thursday, September 22, 2011 11:19 AM
To: Zoli, Elise N
Cc: Stuyvenberg, Andrew; Trach, William J; Gray, Dara F; Julie.Williams@Noaa.Gov; Sutton, Kathryn M.; Dacimo, Fred R.; Mark Mattson; Imboden, Andy; BUCKLEY, RICKY N; Dowell, Kelli; pbessette@morganlewis.com; Turk, Sherwin; Balsam, Briana; Logan, Dennis; Glew Jr, William; Fitzgerald, Robert H; Larry Barnthouse; Mayer, Donald M
Subject: Re: Schedule for final BO

Elise -

Thank you for providing this information. I look forward to receiving the 2010 REMP and the NY State report you reference in your email below. No need to send the FSEIS as I have that already.

We will be in touch re. the schedule soon.

Julie

On 9/21/2011 6:33 PM, Zoli, Elise N wrote:
Julie, consistent with my discussion today with Julie Williams, we very much appreciate NMFS' interest in receiving information relevant to Riverkeeper's September 15, 2011 correspondence, and provide the relevant information below. We request that Riverkeeper's correspondence be addressed, consistent with law, on a courtesy basis, as their correspondence is not authorized by the Section 7 consultation process and we are concerned otherwise may delay conclusion of a process that already has undergone a substantial extension. *See* Final ESA Section 7 Consultation Handbook, March 1998, p. 1-14 *(citing 50 CFR 402.14(g)(5)).* Moreover, while we understand that NMFS may require additional time to issue a final BO, based on NRC's September 20th correspondence (following its September 6th comments) and are willing to allow a reasonable extension there (one that terminates prior to September 30th), we cannot agree to an extension to respond to Riverkeeper's September 15th correspondence.
As Julie Williams and I discussed, NMFS has requested information on two matters: (1) radionuclide discharges; and (2) Indian Point 1's intake system. Each is addressed below, with specific reference to the NRC's Final Supplemental Environmental Impact Statement ("FSEIS").
Radionuclides
With respect to issue #1, radionuclide discharges from Indian Point have been thoroughly assessed, and it has been determined by Entergy, New York and NRC that there are no identified or probable impacts to fish. The matter is addressed in detail in the FSEIS for Indian Point, in Section 2.2.7, pp. 2-104 through 2-114. It expressly reflects analysis of environmental impacts, including potential impacts to "Hudson River water, fish and invertebrates, aquatic vegetation, bottom sediment and shoreline sediment," p. 2-105, and reaches the following conclusions:
(1) that all reviews of radionuclides in the environment (as broadly defined to include aquatic considerations) were found to be non-detectable, naturally occurring or "significantly less than those from" natural background conditions or other anthropogenic conditions" (including "residual levels from atmospheric weapons testing," p. 2-106), p. 2-109;
and, more specifically, with respect to the 2009 REMP:
(2) that "[n]o radionuclides other than those naturally occurring were detected in the Hudson river water samples," p. 2-107 (quoting 2009 REMP report);
(3) that "fish and invertebrate sample analysis results showed there were no plant-related gamma emitting radionuclides detected in 2009," p. 2-107. In this discussion, NRC notes that some of the REMP samples were reported as "not reliable and under review," p. 2-107, with the result that Entergy would submit an addendum . Entergy did address the matter in the 1010 REMP, for which it established a new testing protocol to resolve the 2009 indeterminate results. The 2010 REMP results established no radionuclides in fish above background. (A copy of the 2010 REMP follows, as noted below.)
and, in addition, with respect to Hudson River fish:

(4) that New York State Department of Health (NYSDOH) conducted multi-media investigations, including of fish, confirming that radionuclide levels in the environment in fish in the vicinity of Indian Point were below detection limits or consistent with background radiation, p. 2-109; and
(5) that NYSDOH and the New York State Department of Environmental Conservation (NYSDEC) evaluated radionuclide conditions in fish in the vicinity of Indian Point, and determined that radionuclide levels in fish were no higher than in those fish collected from background locations in other areas of the Hudson River, p. 2-112. (A copy of this assessment follows, as noted below.)
Based upon this information, we believe there is no reasonable or credible basis for concluding any potential risk to fish, including sturgeon. BJ Trach is copied here, and he or I will provide the links to the FSEIS, 2010 REMP and the New York report on fish for your review and records.
Indian Point 1 intake structure

As you are aware, Indian Point 1 (IP1) is retired from electrical generation. On p. 2-13 of the FSEIS, NRC discusses the current use of the IP1 intake structure, which provides some nonessential service water to IP2 on a periodic basis (typically, during some summer months). The IP1 intake structure is in the middle of the same shoreline bulkhead containing the IP2 and IP3 intake structures, but unlike the IP2 and IP3 intakes, the IP1 intake forebays are underneath an existing post and piling dock structure. The IP1 intake structure has two redundant forebays (#11 and #12), each with a maximum or design flow of 10,000 gallons per minute (gpm), employing a dual flow traveling screen equipped with fine mesh screen (1/8 inch; 3.2 mm) panels. While a combined potential flow of 20,000 gpm is theoretically possible, the system as currently configured for IP2 is employed in a redundant matter, such that the maximum flow is from a single forebay, i.e., 10,000 gpm. Further, typical peak operating flow for IP1 is 5,500 gpm, and 6,000 gpm is the limit of the IP2 load, with the result that maximum flow should be considered 6,000 gpm. Employing the 6,000 gpm rate, the maximum pump flow rate represents merely 0.34% of Indian Point's total maximum flow of 1.746 million gpm (IP2 and

IP3 combined circulating and service flows), and we suggest would be considered de minimis by any standards. Moreover, each dual flow traveling screen at IP1's intake has an estimated design through-screen velocity of less than the 0.50 feet per second (fps) through-screen velocity that the United States Environmental Protection Agency (EPA) determined to be protective of 96% of swimming organisms, many smaller and more fragile than shortnose sturgeon. Dr. Mattson, copied here, has confirmed that any healthy sturgeon in the Hudson River of a size subject to impingement could easily escape impingement on the IP1 dual flow traveling screens by swimming away from the low design flow. As NMFS is aware, based on analysis of more than 30 years of extensive river monitoring data, sturgeon eggs and larvae are not present in the vicinity of the Indian Point intake structures and therefore not exposed to entrainment through any screens, including the IP1 dual flow traveling water screens. For completeness sake, please also note that four screen washwater pumps are employed for this system and total 8,000 gpm, although operating procedures rarely employ all four pumps. Based upon this information, we believe that NMFS' draft BO remains correct and comprehensive despite Riverkeeper's correspondence, that no further assessment of IP1's intake is warranted, and that IP1's intake cannot reasonably be construed to cause a separate incidental take of sturgeon. That said, we have agreed to discuss with NMFS a monitoring program, and certainly believe that any such program might include reasonable monitoring requirements for IP1, should NMFS consider such monitoring valuable.

I trust this responds to NMFS' questions, and look forward to issuance of the final BO. Our thanks for your efforts here, and my regards, Elise Zoli

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From: Zoli, Elise N
Sent: Tuesday, September 20, 2011 10:09 PM
To: 'Stuyvenberg, Andrew'; Julie Crocker
Cc: Gray, Dara F; Julie.Williams@Noaa.Gov; Sutton, Kathryn M.; Dacimo, Fred R.; Mark Mattson; Imboden, Andy; BUCKLEY, RICKY N; Dowell, Kelli; pbessette@morganlewis.com; Turk, Sherwin; Balsam, Briana; Logan, Dennis; 'Glew Jr, William'; Fitzgerald, Robert H
Subject: RE: Schedule for final BO

Julie, thanks very much for your email; we appreciate your indicating that NMFS may need additional time to issue its final Biological Opinion (BO). The relevant portion of our extension agreement is quoted below. Based on its language, the extension agreement contemplates that the final biological opinion will be issued no later than September 20th. We, therefore do not read the extension agreement as being effective after that date, consistent with 50 CFR 402.14(e), which both requires a finite deadline and sets a limit on the timeframe within which a final BO must be issued. As importantly, we believe the extension agreement did not guarantee NRC or Entergy comments, but allowed NRC or Entergy to choose what, if anything, they wanted to submit in the timeframe authorized, i.e., by September 6th. As such and as indicated in NRC's email earlier today on this subject, we

understand NRC's submission of technical comments on the draft BO on September 6th constituted its position on the issues, as did our submission by that date on behalf of Entergy.

That said, we understand that NMFS is interested in the benefit of NRC's process-related thoughts, which we understand were received by NMFS today. To that end, we are willing to extend issuance of the deadline for the final BO to Monday, September 26th, to allow NMFS a reasonable opportunity to consider NRC's September 20, 2011 correspondence. Because Entergy's express agreement is required to effect such an extension, we wanted you to have it in writing.

Further, we understand NMFS has two process-related questions, and we believe we can provide relevant assurances to NMFS on those issues, facilitating issuance of the final BO in a timely fashion:

(1) Entergy is willing to include the key elements of the proposed draft biological opinion, as finalized, in its proposed technical specifications to the licenses for IPEC. If we make such a commitment, we believe this provides NMFS with the requisite assurances regarding enforceability of the final BO (conforming to the draft BO while accounting for NMFS' response to comments received to date from Entergy and NRC). While we understand from NRC and our review of applicable regulation that this is not required by law, we believe such an approach is consistent with Entergy's commitment to environmental stewardship.

(2) In my conversation with Julie Williams, I also clarified that we can see no reasonable basis for amendment of the current NRC license renewal application with respect to cooling water intake technology that could trigger reinitiation of consultation under 50 CFR 402.16. To the contrary, consistent with NRC's September 20, 2011 correspondence, the ASLB determined that SPDES issues -- specifically, Section 316(a and b) issues -- will be resolved in the pending NYSDEC proceeding, not before the ASLB on license renewal. If a final Section 316(a, b) decision in the SPDES proceeding requires NRC approval to implement, Entergy would submit such a new application to NRC, as a result of which we understand from NRC 's September 20, 2011 correspondence may precipitate a new consultation with NMFS on that amendment at that time. Likewise, CWIS modifications requiring US Army Corps approval would also trigger consultation with NMFS. For these reasons, we can foresee no situation in which NMFS consultation would not be sought, where required.

Finally, lest there be any confusion, we believe that NMFS' draft biological opinion addressed, within its authority, the proper species, i.e., short-nose sturgeon, and that the absence of discussion of Atlantic sturgeon is appropriate as a matter of law. To that end, while we appreciate that NRC may have an interest in NMFS' views on Atlantic sturgeon, we have identified no legal basis for the proposed further exchange of information**,** potential initiation of a new or different consultation, or the delay that would almost certainly result from either of those actions.

As noted above, the extension language is as follows:

"Ten calendar days after NMFS provides a draft BO to NRC (likely September 6 - first working day after Labor Day) - NRC provides comments from NRC and from Entergy, if any, on the draft BO to NMFS at the end of this 10-calendar day period. If there are no substantive comments, then NMFS prepares the final BO within several days of September 6. If NRC or Entergy submit substantive comments, then NMFS will either prepare a final BO within ten working days (September 20) or NMFS will notify NRC and Entergy of a need for additional time."

As always, I am happy to discuss the above, and my regards, Elise

---

From: Stuyvenberg, Andrew [mailto:Andrew.Stuyvenberg@nrc.gov]
Sent: Tuesday, September 20, 2011 8:37 AM
To: Julie Crocker
Cc: Gray, Dara F; Julie.Williams@Noaa.Gov; Zoli, Elise N; Sutton, Kathryn M.; Dacimo, Fred R.; Mark Mattson; Imboden, Andy; BUCKLEY, RICKY N; Dowell, Kelli; pbessette@morganlewis.com; Turk, Sherwin; Balsam, Briana; Logan, Dennis
Subject: RE: Schedule for BO (revised proposal)

Julie –
The NRC staff transmitted all of its draft BO comments to NMFS on September 6, per our agreement. We have completed our letter in which we respond to Ms. Kurkul's cover letter and will issue it today.
Best regards,
Drew

From: Julie Crocker [mailto:Julie.Crocker@Noaa.Gov]
Sent: Monday, September 19, 2011 4:41 PM
To: Stuyvenberg, Andrew
Cc: Gray, Dara F; Julie.Williams@Noaa.Gov; Zoli, Elise N; Sutton, Kathryn M.; Dacimo, Fred R.; Mark Mattson; Imboden, Andy; BUCKLEY, RICKY N; Dowell, Kelli; pbessette@morganlewis.com; Turk, Sherwin; Balsam, Briana; Logan, Dennis
Subject: Re: Schedule for BO (revised proposal)

All,

Given that NMFS has not yet received all of NRC's comments related to the draft Biological Opinion distributed to NRC on August 25, apparent disagreement regarding the schedule, and in light of the possibility of NMFS needing to address substantive comments, in an abundance of caution, NMFS is writing to indicate that additional time is needed for the consultation to be completed.

Julie

On 6/29/2011 5:31 PM, Stuyvenberg, Andrew wrote:
Dara, others –
The following summarizes my understanding of the schedule for the ongoing ESA Section 7 consultation as agreed-to by NRC, NMFS, and Entergy on this afternoon's teleconference.

- **T (likely July 5; not before July 5)** – Entergy submits information on benthic resources in the action area as discussed on the June 22 teleconference (i.e., information on the biofouling community at the IP intakes, information on the entrainment of amphipods and published studies related to the distribution of the benthic community in the Hudson River). Entergy is also to provide to NRC any relevant thermal information for NRC's revised BA
- **T+20 calendar days (likely July 25, depending on T)** – NRC staff submits BA supplement to NMFS focusing on the assessment of the thermal discharge on shortnose sturgeon.
- **One month after NRC submits BA supplement to NMFS (likely August 25)** - NMFS provides a draft Biological Opinion (BO) to NRC. In completing its BO, NMFS will: (a) review the information provided in the supplemental BA, (b) incorporate the new information on the thermal plume (Swanson et al. 2011, and other sources of information as appropriate) into the draft Opinion, (c) incorporate additional technical information provided by Entergy on the June 22 conference call, (d) make a draft determination as to whether the proposed action is likely to jeopardize the continued existence of shortnose sturgeon and provide justification for this determination, (e) prepare a draft Incidental Take Statement with draft Terms and Conditions and Reasonable and Prudent Measures, as appropriate. Following receipt of the BO, it is NMFS understanding that NRC will distribute the draft BO to Entergy and request that Entergy's comments be submitted to NRC for transmittal to NMFS pursuant to 50 CFR 402.14(g)(5).
- **Ten calendar days after NMFS provides a draft BO to NRC (likely September 6 – first working day after Labor Day)** - NRC provides comments from NRC and from Entergy, if any, on the draft BO to NMFS at the end of this 10-calendar day period.
- **If there are no substantive comments, then NMFS prepares the final BO within several days of September 6.** If NRC or Entergy submit substantive comments, then NMFS will either prepare a final BO within ten working days (September 20) or NMFS will notify NRC and Entergy of a need for additional time.

I believe that captures our agreed-upon timeline, but please reply if I've missed or misconstrued anything.
Best regards,
Drew

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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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November 2009

Table of Contents

INTRODUCTION 2

METHODS 2

RESULTS 4

DISCUSSION 5

CONCLUSIONS 8

ACKNOWLEDGMENTS 8

REFERENCES CITED 9

Table 1: ^{90}Sr concentrations in edible tissues of fish taken from the lower Hudson River in 2006 11

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. 12

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 13

Table 4: Radionuclide concentrations measured in bone of fish from three locations on the lower Hudson River in June 2007. 14

Table 5: Comparison of ^{90}Sr concentrations in bone and edible flesh of fish. 15

Figure 1 16

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.

ACKNOWLEDGMENTS

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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"

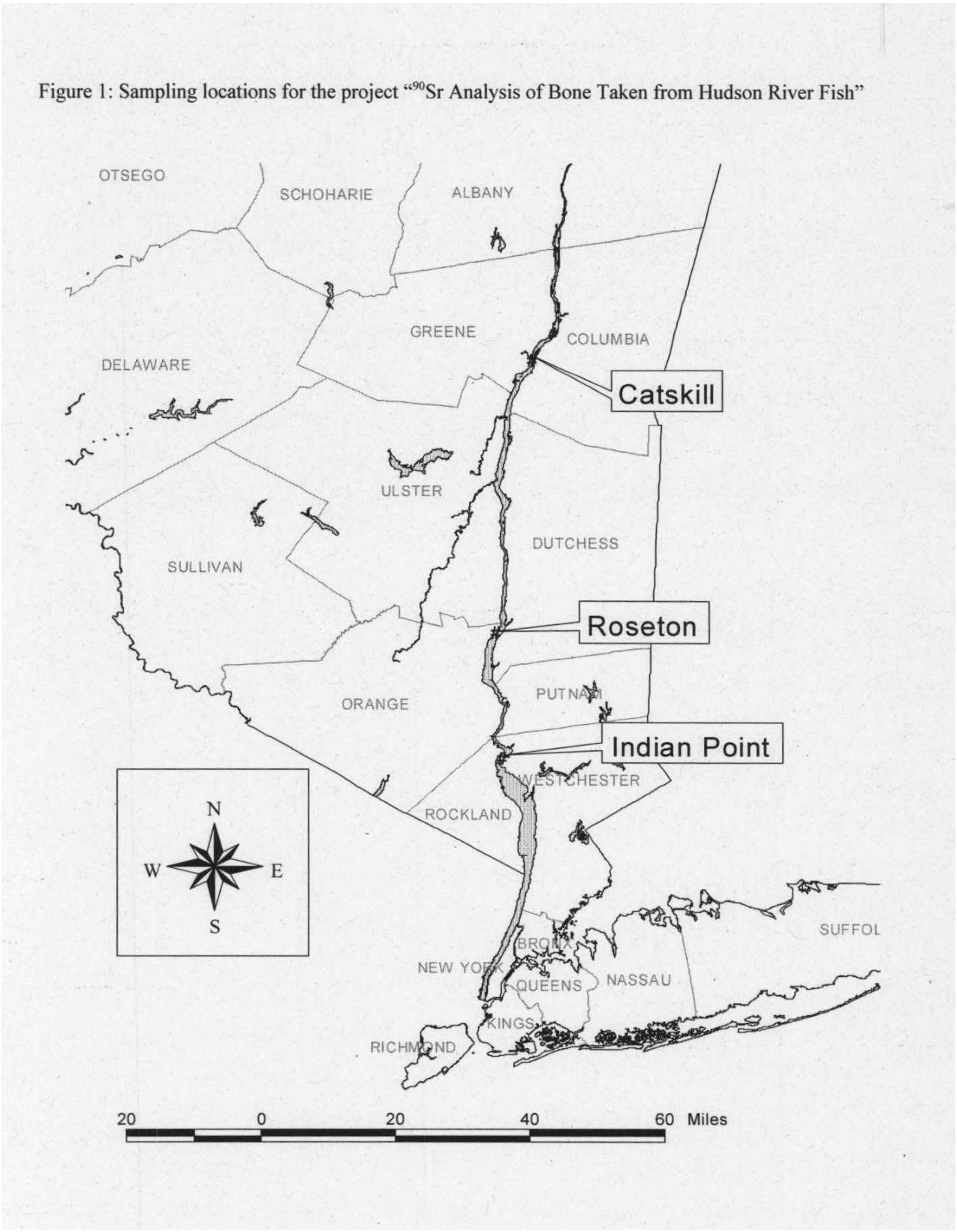

Figure 1

New York State Department of Environmental Conservation
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625 Broadway, Albany, New York 12233-4756
Phone: (518) 402-8924 • **FAX:** (518) 402-8925
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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	

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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	

Recieved 11/2/07 Bryan Weatt
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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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.	Sample 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 Strube	Joseph Strube	John Finn	Tim Preddice	Lawrence C. Skinner
Printed Name: JOAN BLAN	Printed Name: Joseph Strube	Printed Name: Joseph Strube	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	Date: 10/17/07	Date: 10/17/07 1115

12:00 pm page 1 of 6 pg. 1 of 6

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07/19/2007 08:14 FAX 603 472 7052 NORMANDEAU ASSOCIATES 002

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ENVIRONMENTAL CONSULTANTS

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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 2 of 6

Method of Shipment:

Sample No.	Sample Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Presv. FROZEN	Parameters	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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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 URCHURCH

Page 3 of 6

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
1	SUNFISH			1		✓				REG. 7
1	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 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 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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ENVIRONMENTAL CONSULTANTS
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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 5 of 6

Method of Shipment:

Sample No.	Sample Identification	Collection Date	Collection Time	Containers No.	Containers Type	Grab.	Comp.	Presv. FROZEN	Parameters	Comments Below:
34	ROCK BASS	6/18/07	1155	1	ZIPLOCK BAG	✓		↓		REQ. 7
34	PERCH	↓	1155	1	↓	✓				REQ. 7
34	BLUE CRAB	↓	1155	1	↓	✓				REQ. 7
35	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	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
1	PERCH	16
2	PERCH	1
10	S. BASS	1
11	PERCH	4
11	CATFISH	4
11	CARP	1
12	PERCH	1
13	PERCH	1
13	CATFISH	1
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

SAM.#	SPECIES	COUNT
36	CRAB	6
37	CRAB	22
38	CRAB	4
39	EEL	7
44	PERCH	12
44	SUNFISH	3
44	EEL	1
44	CRAB	2
46	SUNFISH	64

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

Green, Kimberly

Full Name:	Julie Crocker
Last Name:	Crocker
First Name:	Julie
Job Title:	Fisheries Biologist
Department:	Protected Resources Division
Company:	NMFS Northeast Regional Office
Business Address:	55 Great Republic Drive Gloucester, MA 01930
Business:	978-281-9300 x6530
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