From: Gray, Dara F <DGray@entergy.com>
Sent: Thursday, May 19, 2016 8:41 AM
To: Wentzel, Michael
Subject: [External_Sender] FW: Year Class Reports
Attachments: 24100 Hudson River 2013 QC.pdf; 24200 Hudson River 2014 QC FINAL.pdf

Importance: High

Mike
Here you go, and sorry again for the delay.

Dara Gray REM
Chemistry/Environmental
Indian Point Energy Center
Dgray@entergy.com
914-254-8414

From: Wentzel, Michael [mailto:Michael.Wentzel@nrc.gov]
Sent: Thursday, April 21, 2016 7:00 AM
To: Gray, Dara F
Cc: Louie, Richard
Subject: Year Class Reports

Dara,

Thank you (and Rich) for sending the 2013 and 2014 Year Class Reports. We are having difficulty getting the files added to ADAMS because the files are password protected. Would it be possible to either get the password to unlock the files, or, unlocked versions of the files?

Please feel free to give me a call if you would like to discuss this further.

Thanks,
Mike

Michael Wentzel
Project Manager
NRR/DLR/RERP
(301) 415-6459
michael.wentzel@nrc.gov

Hearing Identifier: IndianPointUnits2and3NonPublic_EX
Email Number: 6399

Mail Envelope Properties (DA94DFACF1201C4A91A21BD336C2520A23596363)

Subject: [External_Sender] FW: Year Class Reports
Sent Date: 5/19/2016 8:40:35 AM
Received Date: 5/19/2016 8:40:50 AM
From: Gray, Dara F

Created By: DGray@entergy.com

Recipients:
"Wentzel, Michael" <Michael.Wentzel@nrc.gov>
Tracking Status: None

Post Office: LITXMETSP003.etrsouth.corp.entergy.com

Files	Size	Date & Time
MESSAGE	984	5/19/2016 8:40:50 AM
24100 Hudson River 2013 QC.pdf	394610	
24200 Hudson River 2014 QC FINAL.pdf	434978	

Options
Priority: High
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Quality Control Report for the 2013 Hudson River Ichthyoplankton Laboratory Program and 2013 Fall Juvenile Survey

Prepared for:
Indian Point Energy Center
450 Broadway, Suite 1
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Submitted:
July 2014

Prepared by:
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1.0 Introduction

This quality control report for the laboratory tasks of the 2013 Hudson River Ichthyoplankton Survey and the 2013 Fall Juvenile Survey was prepared for Entergy's Indian Point Energy Center by Normandeau Associates Inc. (Normandeau).

To comply with Entergy's requirements for valid and reliable data on the Hudson River Ichthyoplankton Laboratory Program and the Fall Juvenile Survey, Normandeau implemented a Quality Assurance Plan that provides a 10% Average Outgoing Quality Limit (AOQL) for all measurement parameters collected. The Quality Assurance Plan consists of two systems: a quality control (QC) system and a quality assurance (QA) system. The QC system is managed by the program manager and conducted by operational personnel. The system monitors and documents the reliability and validity (accuracy, precision, completeness) of daily operations. The specific features of the QC system are determined by the Quality Assurance Department to insure that all procedures conform to Entergy's data requirements. The QA system is managed by Normandeau's Quality Assurance Director and utilizes project independent personnel familiar with the work or activities under evaluation to conduct performance and systems audits. These audits are designed to provide objective evidence that the quality control program and technical requirements, methods, and procedures as outlined in the program Standard Operating Procedures are being implemented. The outcomes of the QA system activities are

- verification of the effectiveness of the QC system,
- assignment of corrective actions to resolve nonconforming procedures or data deficiencies,
- communication of audit results to project and staff managers for follow-up, and
- objective validation or improvement of project operations.

This report provides a compilation of QC system data verifying the results of the 2013 Hudson River Ichthyoplankton Laboratory Program and 2013 Fall Juvenile Survey activities. Determinations of the fraction inspected, percent nonconforming, and average outgoing quality are presented for both programs. In addition, for the 2013 Hudson River Ichthyoplankton Laboratory Program the results include percent measurement error, a summary of the number of each taxon-life stage found during sorting QC, and cumulative error rates for each taxon-life stage.

2.0 Methods

2.1 Laboratory Quality Control Procedures

2.1.1 Ichthyoplankton Survey

For sorting and identification of samples from the 2013 Hudson River Ichthyoplankton Laboratory Program, Normandeau used a continuous sampling plan designed to provide a 10% AOQL (U.S. Department of Defense 1981). A flow diagram of how the sampling plan was applied is presented in Figure 1. A summary of the sampling plan, tolerances, and QC sample definitions used for each measurement parameter is presented in Table 1. Quality control inspection was applied on a laboratory-wide basis for the sorting task and to each individual processor for the identification task. Quality control samples were selected in a random manner utilizing random number tables. As determined from the sampling plan outlined in Table 1, a specified number of quality control samples were reprocessed by QC inspectors with expertise in the task being inspected. In cases where a sample was subdivided and counted, counts for all subdivisions were combined before calculating percent error for that sample. If the difference between the quality control value and the original value exceeded acceptable tolerances (Table 1), a third measurement could be obtained to verify one of the measurements. If a sample was found to have exceeded acceptable tolerances, all subsequent samples processed by the same technician were subjected to 100% quality control until an appropriate number of consecutive samples (i) were found within tolerance as determined by the continuous sampling plan (Table 1 and Figure 1). The standard operating procedures manual (Normandeau 2014) documents specific QA/QC methods utilized for this program.

Table 1. Task specific applications of continuous sampling plans for the 2013 Hudson River Ichthyoplankton Laboratory Program

Laboratory Task	CSP-1 AOQL 10%		Sample Tolerance	QC Sample Definition
	i	f		
Sorting	8	1/7	± 2 if ≤20 organisms ± 10% if >20 organisms	one sample
Identification	8	1/7	± 2 if ≤20 ± 10% if >20 for every taxon in the sample (in identifying, assigning a life stage, or counting any species, errors are cumulative by life stage within each taxon)	one sample

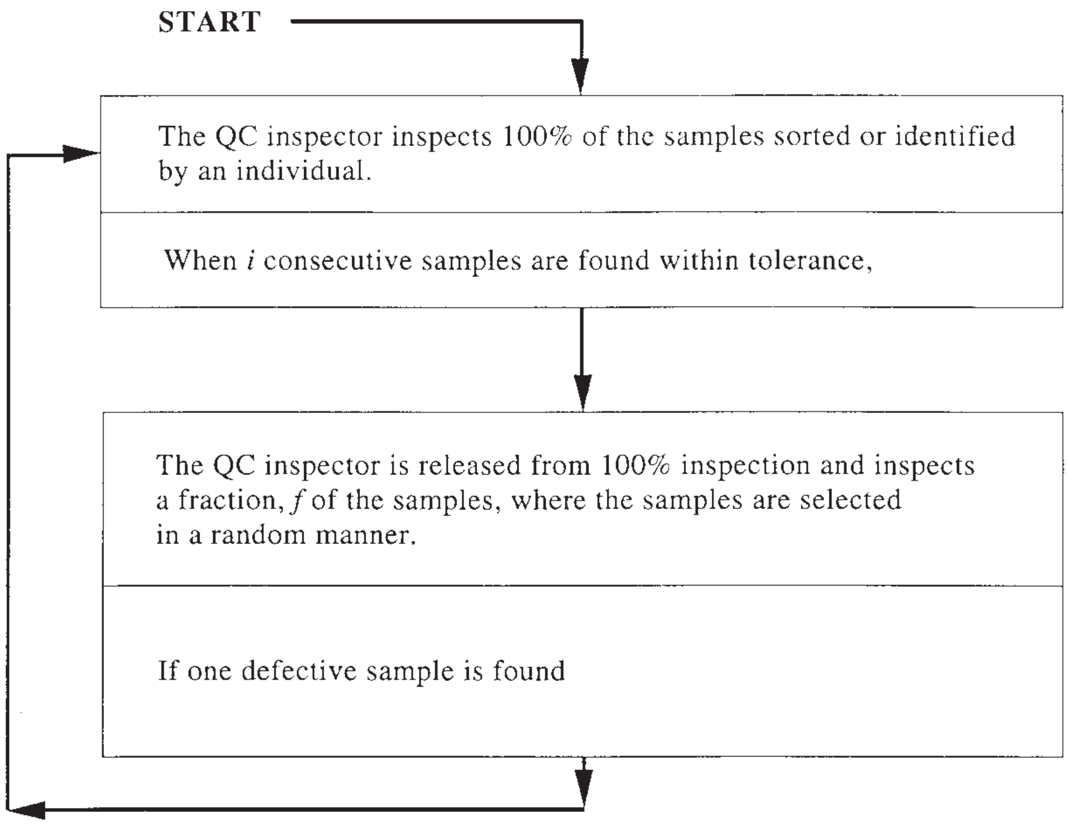

Figure 1. Quality control inspection plan for ichthyoplankton sorting and identification tasks.

In some cases one of the taxonomists (either the original identifier or the QC inspector) was able to determine the taxon or life stage of damaged specimens when the other taxonomist recorded them as unknown life stage, unidentified taxon, or a higher level taxon (genus or family). If a more general taxon or life stage used by one taxonomist *included* the more specific category used by the other taxonomist, and that was the only reason for a count discrepancy, then that sample was not considered as failing the QC inspection. For example, damaged specimens recorded as *Morone* sp. by the original identifier and as Striped Bass by the QC inspector were considered to be in agreement because the category *Morone* sp. includes Striped Bass. In contrast, an original determination of unidentified gobiid would not be acceptable if the QC determination was Striped Bass, because Striped Bass is not included in the family Gobiidae.

2.1.2 Fall Juvenile Survey

The Fall Juvenile Survey consisted of two types of collections, referred to as the Fall Shoals Survey (which used Tucker trawls) and the Beach Seine Survey. For laboratory identification and length measurements of young-of-the-year fishes in the 2013 Fall Juvenile Survey, Normandeau used a continuous sampling plan designed to provide a 10% Average Outgoing Quality Limit (U.S. Department of Defense, 1981). A flow diagram of how the plan was applied is presented in Figure 2. A summary of the sampling plan, tolerances, and QC sample definitions used for each task is shown in Table 2. QC samples were selected as specified by the appropriate plan in Table 2, using random numbers, and reprocessed by QC inspectors. If the difference between original and QC values exceeded the acceptable tolerance, a third value was obtained as a resolution. The standard operating procedures manual (Normandeau 2013) documents specific QA/QC methods used for the 2013 Fall Juvenile Survey. Young-of-the-year fishes were identified in the laboratory for the first two Fall Shoals Survey "river runs" (sampling weeks) and the first three Beach Seine Survey river runs. Young-of-the-year fishes were identified in the field starting with Fall Shoals Survey river run 3 and Beach Seine Survey river run 4. The same quality control procedures applied to both field and laboratory identifications. All length measurements of young-of-the-year fishes occurred in the laboratory.

Table 2. Task specific applications of continuous sampling plans for the 2013 Fall Juvenile Survey.

Task	QC Plan	AOQL	i	f	x	Tolerance	QC Sample Definition
Identification	CSP-V	7%	21	1/15	7	±10% of total count or ±2 individuals when <25 fish	One taxon
Length	CSP-V	7%	30	1/50	10	±1 mm when <34 mm TL ±3% when >34 mm TL	One fish

2.2 Reporting Procedures

The 2013 Hudson River Ichthyoplankton Laboratory Program Sort and Identification Quality Control Logs were keyed, verified, and error-checked to produce SAS data sets. From these data, fraction inspected, percent nonconforming, and percent measurement error (precision) were determined for each river run and for the entire study. For the 2013 Fall Juvenile Survey, QC data were used to determine fraction inspected and percent nonconforming for the entire study (combining all river runs processed in the laboratory for both the Fall Shoals Survey and the Beach Seine Survey).

2.2.1 Fraction Inspected

Fraction Inspected

$$= \frac{\text{Number of Samples Inspected}}{\text{Total Number of Samples}} \times 100 \qquad \text{(Equation 1)}$$

River Run: Fraction inspected for a river run (Equation 1) was one hundred times the number of samples inspected divided by the total number of samples analyzed for that river run. For the ichthyoplankton sorting task, the number of samples inspected excludes "training QC samples" for new sorters, which do not represent the independent performance of the technician, as well as the samples inspected as part of the QC plan. For the identification task, the total number of samples identified excludes empty ("no catch") samples, which did not require processing by an identifier.

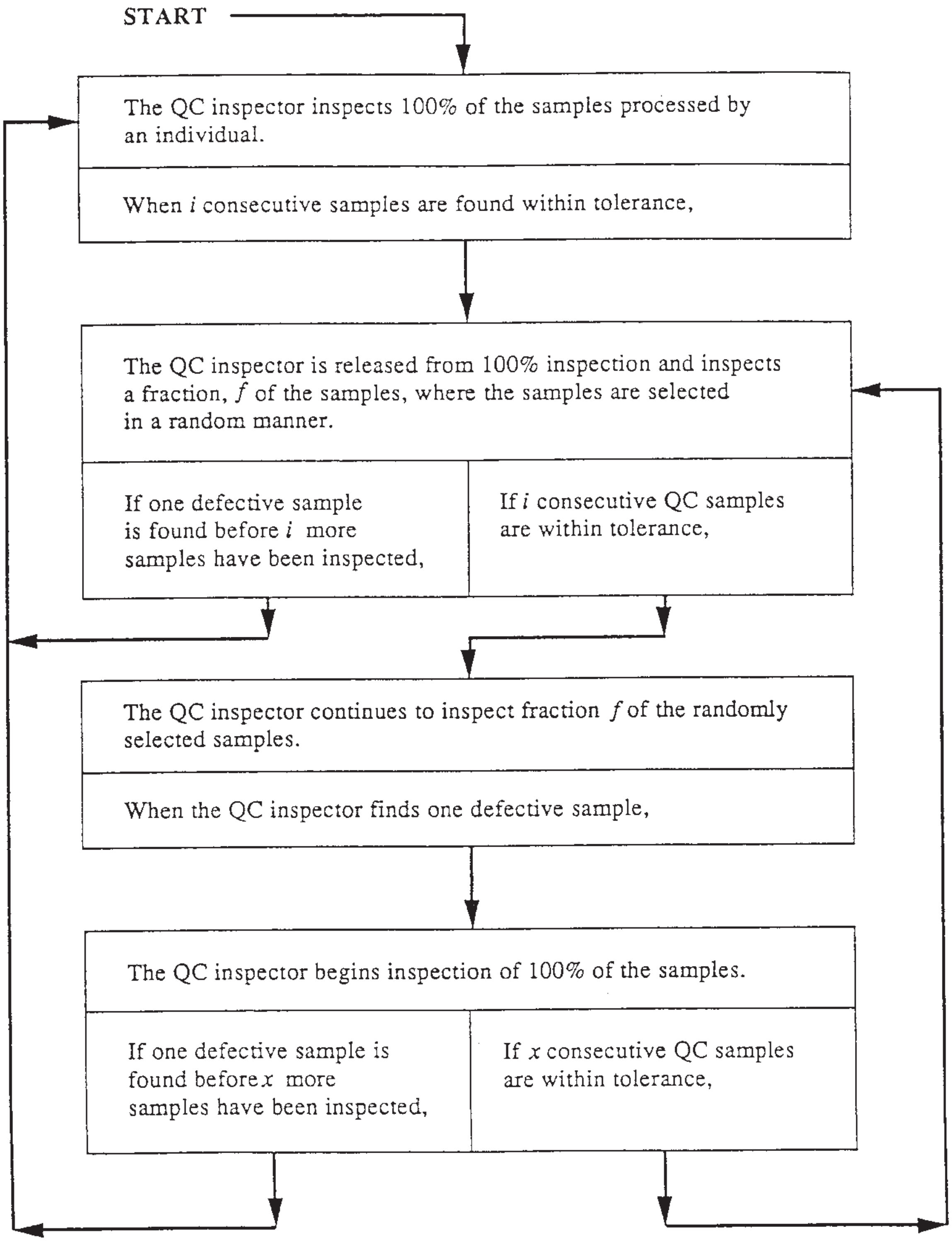

Figure 2. Quality control inspection plan for identification and length measurement of young-of-the-year fishes.

Entire Study: Fraction inspected for the entire study was one hundred times the number of samples inspected divided by the total number of samples analyzed during the study.

2.2.2 Percent Nonconforming

Percent Nonconforming

$$= \frac{\text{Number of Nonconforming Samples Inspected}}{\text{Number of Samples Inspected}} \times 100 \qquad \text{(Equation 2)}$$

River Run: Percent nonconforming for a river run (Equation 2) was one hundred times the number of nonconforming quality control samples found for that river run divided by the total number of quality control samples inspected for that river run.

Entire Study: Percent nonconforming for the entire study was one hundred times the total number of nonconforming quality control samples for the study divided by the total number of quality control samples inspected for the study. The result of this analysis was a determination of the actual incoming quality level of each measurement parameter. (Note that because samples checked by QC found to be defective were rectified during QC, the average outgoing quality of the final data set was better than that indicated by the percent nonconforming.)

2.2.3 Percent Measurement Error

Sorting Task

Sorting Percent Measurement Error

$$= \frac{\text{Quality Control Value}}{(\text{Original Value} + \text{Quality Control Value})} \times 100 \qquad \text{(Equation 3)}$$

Sample: Percent measurement error for a sorted sample (Equation 3) was one hundred times the quality control value divided by the sum of the original value and the quality control value. If the total count (original value plus quality control value) was less than or equal to 20, and the quality control value (i.e., the number of organisms missed by the sorter and found during sort QC inspection) was no more than two, the percent measurement error for the sorted sample was defined as zero.

River Run: Mean percent measurement error for sorted samples for a river run was the sum of the percent measurement errors for each sample inspected during the river run divided by the total number of samples inspected for the river run.

Entire Study: Mean percent measurement error for sorted samples for the entire study was the sum of the percent measurement errors for each sample inspected during the study divided by the total number of samples inspected for the study. (Note that this method of averaging gives equal weight to each sample, regardless of the number of organisms present).

Identification Task

Life Stage Percent Measurement Error

$$= \frac{(\text{Original Value} - \text{Quality Control Value})}{\text{Quality Control Value}} \times 100 \qquad \text{(Equation 4)}$$

Life Stage: Percent measurement error for a life stage (Equation 4) was one hundred times the difference between the original value and the quality control value divided by the quality control value. For life stages where the quality control value was 20 or less, if the original and quality control values differed by no more than two organisms, the percent measurement error was defined as zero. For life stages where the quality control value was 20 or less and the original and quality control values differed by more than two organisms, the percent measurement error was calculated utilizing Equation 4. If the quality control value was zero, the percent measurement error was calculated by multiplying the difference between the original and quality control values by 100. This can occasionally result in extremely large percent measurement error values (as much as several hundred percent for a life stage of a taxon in a sample), which are not truly indicative of the actual proportion of specimens misidentified, assigned to the wrong life stage, or miscounted in a sample. If the original count for a life stage was acceptably close to a resolution value but not to the quality control value, the percent measurement error was calculated as described above except that the resolution value was substituted for the quality control value.

Taxon: Percent measurement error for an identified taxon was the sum of the absolute values of percent measurement error for each life stage within the taxon. Refer to Figure 3 for an example of taxon percent measurement error calculations.

		Eggs	Post Yolk-Sac Larvae	Young-of-the-Year	Total
Taxon 1					
	Original Value	103	176	25	
	Quality Control Value	100	194	26	
	% Measurement Error Life Stage	3.0	-9.3	-3.8	16.1
Taxon 2					
	Original Value		2		
	Quality Control Value		1		
	% Measurement Error Life Stage		0		0
Taxon 3					
	Original Value		8		
	Quality Control Value		2		
	% Measurement Error Life Stage		300		300

Figure 3. Example of percent measurement error calculations for individual taxa during the identification task.

River Run: Mean percent measurement error for the identification task for a river run was the sum of the percent measurement errors for all taxa inspected during the river run divided by the total number of taxa inspected for the river run. This statistic was computed by averaging taxa rather than samples because even though complete samples were inspected and reworked for identification quality control, the pass/fail criterion was whether any taxon in the sample individually exceeded the 10% tolerance.

Entire Study: Mean percent measurement error for identified taxa for the entire study was the sum of the percent measurement errors for all taxa inspected during the study divided by the total number of taxa inspected for the study.

2.2.4 Average Outgoing Quality

At the completion of these studies, the Average Outgoing Quality (AOQ) was calculated for each measurement parameter inspected. Continuous sampling plans were used for all tasks. Continuous sampling plans are devised for processes involving a continuous or nearly continuous flow of products or other entities. For these types of processes, it is extremely difficult to organize units into discrete groups commonly referred to as lots. As a result, inspection must be performed on individual units drawn from a continuous flow of products and a decision made concerning the quality of units produced based on the inspection results. Rectification is performed on any nonconforming unit found during inspection, followed by 100% screening of a number of subsequent units depending on the sampling plan. Average Outgoing Quality for each laboratory task was calculated as a function of the percent nonconforming and the fraction of total units inspected (Stephens 1979). This calculation applies to continuous sampling plans when nonconforming units found are rectified:

$$AOQ = \frac{p'(1-f)q^{i}}{f+(1-f)q^{i}} \times 100 \qquad \text{(Equation 5)}$$

where

p' = Percent nonconforming as a decimal fraction
f = Fraction of units inspected. This is a parameter of the sampling plan.
Q = 1-p' = Percent conforming as a decimal fraction
I = Clearing interval. This is a parameter of the sampling plan.

Example:

p' = 0.0689
f = 1/7 = 0.1429
q = 1-0.0689 = 0.9311
i = 8

$$AOQ = \frac{0.0689(1-0.1429)(0.9311)^{8}}{0.1429+(1-0.1429)(0.9311)^{8}} \times 100 = 5.32\%$$

The above equation for calculating AOQ was formulated specifically for CSP-1 sampling plans such as those used for the ichthyoplankton sorting and identification (Table 1). The same equation was used to calculate AOQ for young-of-the-year identifications and measurements, which used CSP-V plans (Table 2). When Equation 5 is used for CSP-V plans, the calculated AOQ is conservatively high, because the equation does not take into account the times when the number of consecutive reinspections following a failure is x (which is smaller than i).

2.2.5 Cumulative Error Rates

Due to the non-independence of identification errors across taxa and life stages, and to the accumulation of errors within taxa, a relatively high fraction of samples may fail QC inspection even though only a small fraction of organisms are incorrectly identified or counted. In order to present the error frequencies more realistically for particular taxa-life stages, two additional statistics were calculated for each taxon-life stage for the identification/counting process.

Absolute Error Rate =

$$\sum_{i=1}^{n} | I_i - Q_i | / \sum_{i=1}^{n} Q_i \qquad \text{Equation 6}$$

Net Error Rate =

$$\sum_{i=1}^{n} (I_i - Q_i) / \sum_{i=1}^{n} Q_i \qquad \text{Equation 7}$$

where

I_i = initial count for taxon-life stage in sample i

Q_i = QC count for taxon-life stage in sample i (or the resolution count, if I_i was acceptably close to it but not to the QC count)

n = number of samples in the entire study

If the sum of Q_i for the entire study was zero for the taxon-life stage, then the sum of Q_i was set equal to one for the purpose of calculating absolute and net error rate.

The absolute error rate is the approximate fraction of the taxon-life stage that was originally identified or counted incorrectly. This is an estimate of the fraction of erroneous countable items in the uninspected samples.

Net error rate is the approximate relative error in the total counts for the taxon-life stage. For this index, positive (original count too high) and negative (original count too low) errors cancel each other so that the index reflects the relative net bias to the taxon-life stage abundance.

3.0 Results

3.1 Ichthyoplankton Laboratory Program

The Average Outgoing Quality (AOQ) of the 2013 Hudson River Ichthyoplankton Laboratory Program was 6.41% for the sorting task and 0.52% for the identification task. These AOQ levels represent the actual or achieved quality for measurement parameters and were within the 10% AOQL requirement of the study. The Average Fraction Inspected (AFI) was 35.81% for sorting and 15.34% for identification (Table 3).

Table 3. Fraction inspected, percent nonconforming, mean percent measurement error, and average outgoing quality of tasks performed by Normandeau for the 2013 Hudson River Ichthyoplankton Laboratory Program.

Task	Fraction Inspected (%)	Percent Noncon-forming (%)	Mean Percent Measurement Error (%)	AOQ (%)
Sorting	35.81	8.60	2.97	6.41
Identification	15.34	0.61	0.92	0.52

Sorting and identification tasks were also evaluated on the basis of river runs (sampling weeks). Sorted samples were inspected at a rate of 14.81% to 62.70% for individual river runs (Table 4). Nonconformance for the sorting task among the inspected samples ranged from 0% to 18.33% in the 23 river runs, and averaged 8.60% overall (Table 5). Sorting measurement error was between 0% and 6.10% and averaged 2.97% for the study (Table 6). For the task of sample identification, 10.0% to 39.51% of samples were inspected from individual river runs (Table 7). Percent nonconforming for the identification task in individual river runs ranged from 0% to 11.11% (Table 8). Measurement error for individual river runs ranged from 0% to 6.25% and overall measurement error was 0.92% for the identification task of this study (Table 9).

Measurement error results for the identification task are skewed towards high values as a result of the method of computation at the life stage level. In addition, measurement errors are summed over life stages within each taxon, which then amplifies the already skewed life stage values. These data are not indicative of actual measurement error and should only be compared to other measurement error results that are calculated using exactly the same methods. In all cases of failed QC samples, the data were corrected and the QC sample inspection frequency was maintained at 100% for that individual until acceptable results were demonstrated as determined by the QC sampling plan.

Table 4. Sample sorting fraction inspected results, 2013 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total # of Samples Inspected	Total # of Samples Sorted	Fraction Inspected (%)
11 Mar 13	13	74	17.57
18 Mar 13	37	74	50.00
25 Mar 13	34	74	45.95
1 Apr 13	54	126	42.86
8 Apr 13	39	126	30.95
15 Apr 13	36	126	28.57
22 Apr 13	31	135	22.96
29 Apr 13	41	135	30.37
6 May 13	61	135	45.19
13 May 13	79	126	62.70
20 May 13	55	126	43.65
27 May 13	60	126	47.62
3 Jun 13	49	123	39.84
10 Jun 13	58	123	47.15
17 Jun 13	49	123	39.84
24 Jun 13	21	122	17.21
8 Jul 13	24	81	29.63
22 Jul 13	22	75	29.33
5 Aug 13	12	81	14.81
19 Aug 13	42	81	51.85
2 Sep 13	19	81	23.46
16 Sep 13	16	81	19.75
30 Sep 13	20	81	24.69
Study	**872**	**2,435**	**35.81**

Table 5. Sample sorting percent nonconformance results, 2013 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	# of Noncon-formities	Total # of Samples Inspected	% Non-conformance
11 Mar 13	0	13	0.00
18 Mar 13	1	37	2.70
25 Mar 13	2	34	5.88
1 Apr 13	2	54	3.70
8 Apr 13	3	39	7.69
15 Apr 13	0	36	0.00
22 Apr 13	2	31	6.45
29 Apr 13	5	41	12.20
6 May 13	4	61	6.56
13 May 13	8	79	10.13
20 May 13	4	55	7.27
27 May 13	11	60	18.33
3 Jun 13	7	49	14.29
10 Jun 13	8	58	13.79
17 Jun 13	8	49	16.33
24 Jun 13	2	21	9.52
8 Jul 13	2	24	8.33
22 Jul 13	1	22	4.55
5 Aug 13	1	12	8.33
19 Aug 13	3	42	7.14
2 Sep 13	0	19	0.00
16 Sep 13	0	16	0.00
30 Sep 13	1	20	5.00
Study	**75**	**872**	**8.60**

Table 6. Sample sorting mean percent measurement error results, 2013 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total # of Samples Inspected	Mean Percent Measurement Error
11 Mar 13	13	0.00
18 Mar 13	37	0.90
25 Mar 13	34	4.19
1 Apr 13	54	1.54
8 Apr 13	39	2.17
15 Apr 13	36	0.21
22 Apr 13	31	3.87
29 Apr 13	41	3.36
6 May 13	61	2.08
13 May 13	79	3.48
20 May 13	55	2.22
27 May 13	60	6.10
3 Jun 13	49	3.86
10 Jun 13	58	4.44
17 Jun 13	49	4.61
24 Jun 13	21	3.30
8 Jul 13	24	2.07
22 Jul 13	22	2.55
5 Aug 13	12	2.19
19 Aug 13	42	4.40
2 Sep 13	19	0.44
16 Sep 13	16	0.52
30 Sep 13	20	0.69
Study	**872**	**2.97**

Table 7. Sample identification fraction inspected results, 2013 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total # of Samples Inspected	Total # of Samples Identified	Fraction Inspected (%)
11 Mar 13	8	53	15.09
18 Mar 13	8	57	14.04
25 Mar 13	10	68	14.71
1 Apr 13	9	66	13.64
8 Apr 13	10	63	15.87
15 Apr 13	8	47	17.02
22 Apr 13	10	83	12.05
29 Apr 13	14	128	10.94
6 May 13	25	134	18.66
13 May 13	18	124	14.52
20 May 13	17	126	13.49
27 May 13	19	126	15.08
3 Jun 13	15	123	12.20
10 Jun 13	18	123	14.63
17 Jun 13	18	123	14.63
24 Jun 13	17	122	13.93
8 Jul 13	14	81	17.28
22 Jul 13	12	75	16.00
5 Aug 13	8	80	10.00
19 Aug 13	32	81	39.51
2 Sep 13	13	81	16.05
16 Sep 13	10	81	12.35
30 Sep 13	13	80	16.25
Study	**326**	**2,125**	**15.34**

Table 8. Sample identification percent nonconformance results, 2013 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	# of Noncon-formities	Total # of Samples Inspected	% Non-conformance
11 Mar 13	0	8	0.00
18 Mar 13	0	8	0.00
25 Mar 13	0	10	0.00
1 Apr 13	0	9	0.00
8 Apr 13	0	10	0.00
15 Apr 13	0	8	0.00
22 Apr 13	0	10	0.00
29 Apr 13	0	14	0.00
6 May 13	0	25	0.00
13 May 13	0	18	0.00
20 May 13	0	17	0.00
27 May 13	0	19	0.00
3 Jun 13	0	15	0.00
10 Jun 13	2	18	11.11
17 Jun 13	0	18	0.00
24 Jun 13	0	17	0.00
8 Jul 13	0	14	0.00
22 Jul 13	0	12	0.00
5 Aug 13	0	8	0.00
19 Aug 13	0	32	0.00
2 Sep 13	0	13	0.00
16 Sep 13	0	10	0.00
30 Sep 13	0	13	0.00
Study	**2**	**326**	**0.61**

Table 9. Sample identification mean percent measurement error results, 2013 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total # of Samples Inspected	Mean Percent Measurement Error	Number of Taxa Inspected
11 Mar 13	8	0.36	17
18 Mar 13	8	0.19	25
25 Mar 13	10	0.00	19
1 Apr 13	9	0.00	29
8 Apr 13	10	0.00	20
15 Apr 13	8	0.00	16
22 Apr 13	10	0.23	19
29 Apr 13	14	0.09	34
6 May 13	25	0.22	65
13 May 13	18	0.31	58
20 May 13	17	0.71	70
27 May 13	19	0.79	98
3 Jun 13	15	0.80	79
10 Jun 13	18	6.25	106
17 Jun 13	18	0.48	106
24 Jun 13	17	0.38	87
8 Jul 13	14	0.41	84
22 Jul 13	12	0.67	46
5 Aug 13	8	0.06	44
19 Aug 13	32	0.25	123
2 Sep 13	13	0.51	31
16 Sep 13	10	0.56	21
30 Sep 13	13	0.27	22
Study	**326**	**0.92**	**1,219**

Additional organisms found during the sort QC were identified independently to determine the frequency of species and life stages missed during the initial sort. Six taxa accounted for 91% of the additional organisms found during sort QC: Striped Bass, White Perch, herring family, Bay Anchovy, *Morone* sp., and Freshwater Drum (Table 10). For these six taxa, the additional number found in the sort QC amounted to less than 2% of the total found during sample processing (Table 11). For most taxa-life stages the percentage missed by the original sorter was well under 5%.

The life stage most commonly missed by sorters was post yolk-sac larvae for White Perch, clupeids, and *Morone* sp.; eggs for Bay Anchovy and Freshwater Drum; and yolk-sac larvae for Striped Bass (Table 11). The life stage most frequently missed by sorters was usually the most abundant life stage.

During the identification process, absolute error rates for individual life stages of commonly encountered taxa ranged were usually less than 0.02. Generally, only those taxa-life stages with low total counts had absolute error rates above 0.05 (Table 12).

Net error rates were substantially lower than the absolute error rates in most cases, demonstrating that errors often tended to cancel each other out. This was especially noticeable for many of the most abundant taxa-life stages, such as Bay Anchovy eggs and Striped Bass yolk-sac larvae and post yolk-sac larvae.

3.2 Fall Juvenile Survey

Results of the laboratory quality control program for the 2013 Fall Juvenile Survey (consisting of the Beach Seine Survey and the Fall Shoals Survey) were summarized by the same methods as the QC results for the 2013 Hudson River Ichthyoplankton Laboratory Program and are presented in Table 13.

There were 516 and 911 young-of-the-year fish identification records made in the laboratory for the Fall Shoals and Beach Seine surveys respectively and 4,084 and 3,536 young-of-the-year fish length measurement records were made for the Fall Shoals and Beach Seine surveys respectively.

Table 10. Ranking of taxa missed during initial sort and found during sort QC.

Taxon	Number of Organisms Found in Sort QC	Percent
Striped Bass	2,090	32.87
White Perch	1,888	29.69
Herring family	1,027	16.15
Bay Anchovy	485	7.63
Morone species	159	2.50
Freshwater Drum	158	2.48
Unidentified	108	1.70
Winter Flounder	90	1.42
Tautog	85	1.34
Cunner	74	1.16
Goby family	51	0.80
Gizzard Shad	32	0.50
Fourbeard Rockling	23	0.36
Atlantic Tomcod	16	0.25
Hogchoker	13	0.20
Atlantic Menhaden	12	0.19
Carp and minnow family	8	0.13
Windowpane	8	0.13
Weakfish	7	0.11
Atlantic Croaker	6	0.09
Common Carp	4	0.06
Fourspot Flounder	3	0.05
Inland Silverside	3	0.05
American Shad	2	0.03
Yellow Perch	2	0.03
Atlantic Cod	1	0.02
Butterfish	1	0.02
Menidia species	1	0.02
Northern Pipefish	1	0.02
Pollock	1	0.02
Total	**6,359**	**100.00**

Table 11. Summary by life stage of the six highest ranked taxa missed during original sort and found during sort QC compared to total count.

Taxon	Life Stage	Number	Percent in Each Stage	Percent of Total Found	Total Organisms Found[a]
Bay Anchovy	Eggs	391	80.62	1.06	36,727
	Yolk-sac larvae	7	1.44	4.32	162
	Post yolk-sac larvae	87	17.94	0.47	18,670
	Young-of-the-year	0	0.00	0.00	4,628
	Unidentified	0	0.00	0.00	16
Freshwater Drum	Eggs	114	72.15	2.41	4,737
	Yolk-sac larvae	30	18.99	1.25	2,406
	Post yolk-sac larvae	13	8.23	0.91	1,428
	Young-of-the-year	0	0.00	0.00	1
	Unidentified	1	0.63	5.88	17
Herring family	Eggs	193	18.79	1.63	11,813
	Yolk-sac larvae	173	16.85	5.02	3,449
	Post yolk-sac larvae	653	63.58	2.80	23,291
	Unidentified	8	0.78	7.62	105
Morone species	Yolk-sac larvae	13	8.18	8.13	160
	Post yolk-sac larvae	91	57.23	2.47	3,677
	Unidentified	55	34.59	2.48	2,219
Striped Bass	Eggs	649	31.05	1.41	45,915
	Yolk-sac larvae	786	37.61	1.71	45,927
	Post yolk-sac larvae	639	30.57	0.79	81,178
	Young-of-the-year	0	0.00	0.00	183
	Unidentified	16	0.77	3.90	410
White Perch	Eggs	344	18.22	3.97	8,664
	Yolk-sac larvae	295	15.63	3.22	9,163
	Post yolk-sac larvae	1,237	65.52	2.79	44,295
	Young-of-the-year	0	0.00	0.00	42
	Unidentified	12	0.64	5.36	224

[a] Includes both original count and additional organisms found during sort QC.

Table 12. Cumulative net and absolute error rates for commonly encountered taxa in samples selected for QC inspection of identification and counting process.

Taxon	Stage	Total Count	Net Error	Absolute Error	N
Atlantic Menhaden	Eggs	124	-0.00806	0.00806	7
	Post Yolk Sac Larvae	879	-0.00228	0.00455	83
Atlantic Tomcod	Young of the Year	168	-0.02381	0.03571	44
	Yolk-Sac Larvae	3	0.00000	0.00000	2
	Post Yolk Sac Larvae	138	0.00000	0.00000	28
Bay Anchovy	Young of the Year	222	0.00000	0.00000	48
	Unidentified	0	1.00000	1.00000	1
	Eggs	4,569	-0.00263	0.00875	57
	Yolk-Sac Larvae	73	0.04110	0.04110	4
	Post Yolk Sac Larvae	3,963	-0.00606	0.01060	101
	Young of the Year	840	0.01429	0.01905	61
Freshwater Drum	Unidentified	2	0.00000	0.00000	1
	Eggs	156	0.00000	0.00000	5
	Yolk-Sac Larvae	204	0.00980	0.03922	20
	Post Yolk Sac Larvae	255	-0.05098	0.05098	24
	Young of the Year	1	0.00000	0.00000	1
Goby family	Unidentified	1	0.00000	0.00000	1
	Post Yolk Sac Larvae	1,007	-0.00695	0.01291	68
Herring family	Unidentified	9	0.11111	0.11111	5
	Eggs	1,340	-0.00896	0.00896	16
	Yolk-Sac Larvae	310	-0.00323	0.01613	33
	Post Yolk Sac Larvae	2,558	-0.00156	0.01407	101
Hogchoker	Eggs	692	-0.00289	0.00867	16
	Yolk-Sac Larvae	30	-0.03333	0.03333	5
	Post Yolk Sac Larvae	4	0.25000	0.25000	4
	Young Of The Year	5	0.00000	0.00000	3
Morone species	Unidentified	263	-0.00760	0.09125	28
	Yolk-Sac Larvae	6	0.00000	0.33333	4
	Post Yolk Sac Larvae	646	0.00464	0.03870	41
Striped Bass	Unidentified	28	0.10714	0.17857	7
	Eggs	4,207	0.00071	0.00071	59
	Yolk-Sac Larvae	4,889	0.00900	0.02168	78
	Post Yolk Sac Larvae	10,275	-0.00467	0.01071	114
	Young of the Year	41	0.00000	0.00000	14
Weakfish	Eggs	647	0.00155	0.01700	9
	Post Yolk Sac Larvae	30	0.00000	0.00000	14
	Young Of The Year	22	0.00000	0.00000	10

(continued)

Table 12. (Continued)

Taxon	Stage	Total Count	Net Error	Absolute Error	N
White Perch	Unidentified	8	0.12500	0.12500	3
	Eggs	936	-0.00641	0.00641	27
	Yolk-Sac Larvae	586	0.02218	0.03242	49
	Post Yolk Sac Larvae	4,015	-0.00897	0.02092	88
	Young of the Year	3	0.00000	0.00000	2
Winter Flounder	Unidentified	2	0.00000	0.00000	1
	Yolk-Sac Larvae	16	0.00000	0.00000	8
	Post Yolk Sac Larvae	170	0.00000	0.01176	27
	Young of the Year	13	0.00000	0.00000	5

Table 13. Fraction inspected, percent nonconforming, and average outgoing quality of laboratory tasks performed by Normandeau for the 2013 Fall Juvenile Survey.

Task	Average Fraction Inspected (%)	Percent Nonconforming (%)	Average Outgoing Quality (%)
Identification	6.66	0.00	0.00
Measurement	2.03	0.00	0.00

4.0 Literature Cited

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Quality Control Report for the 2014 Hudson River Ichthyoplankton Laboratory Program and 2014 Fall Juvenile Survey

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1.0 Introduction

This Quality Control (QC) report for the laboratory tasks of the 2014 Hudson River Ichthyoplankton Survey, 2014 Fall Juvenile Survey and, 2014 Beach Seine Survey was prepared for Entergy's Indian Point Energy Center by Normandeau Associates Inc. (Normandeau).

To comply with Entergy's requirements for valid and reliable data on the Hudson River Ichthyoplankton Laboratory Program and the Fall Juvenile and Beach Seine Survey's, Normandeau implemented a Quality Assurance Plan that provides a 10% Average Outgoing Quality Limit (AOQL) for all measurement parameters collected. The Quality Assurance Plan consists of two systems: a Quality Control (QC) system and a Quality Assurance (QA) system. The QC system is managed by the program manager and conducted by operational personnel. The system monitors and documents the reliability and validity (accuracy, precision, completeness) of daily operations. The specific features of the QC system are determined by the Quality Assurance Department to insure that all procedures conform to Entergy's data requirements. The QA system is managed by Normandeau's Quality Assurance Director and utilizes project independent personnel familiar with the work or activities under evaluation to conduct performance and systems audits. These audits are designed to provide objective evidence that the QC program and technical requirements, methods, and procedures as outlined in the program Standard Operating Procedures are being implemented. The outcomes of the QA system activities are

- verification of the effectiveness of the QC system,
- assignment of corrective actions to resolve nonconforming procedures or data deficiencies,
- communication of audit results to project and staff managers for follow-up, and
- objective validation or improvement of project operations.

This report provides a compilation of QC system data verifying the results of the 2014 Hudson River Ichthyoplankton Laboratory Program and 2014 Fall Juvenile and Beach Seine Survey's activities. Determinations of the percent inspected, percent nonconforming, and average outgoing quality are presented for both programs. In addition, for the 2014 Hudson River Ichthyoplankton Laboratory Program the results include percent error, a summary of the number of each taxon-life stage found during sorting QC, and cumulative error rates for each taxon-life stage.

2.0 Methods

2.1 Laboratory Quality Control Procedures

2.1.1 Ichthyoplankton Survey

The Ichthyoplankton Survey collected samples by a 1-m wide epibenthic sled and a 1-m^2 Tucker trawl, each with a 500 µm mesh net. For sorting and identification of samples from the 2014 Hudson River Ichthyoplankton Laboratory Program, Normandeau used a continuous sampling plan designed to provide a 10% AOQL (U.S. Department of Defense 1981). A flow diagram of how the sampling plan was applied is presented in Figure 1. A summary of the sampling plan, tolerances, and QC sample definitions used for each measurement parameter is presented in Table 1. QC inspection was applied on a laboratory-wide basis for the sorting task and to each individual processor for the identification task. Samples were selected in a random manner utilizing random number tables. As determined from the sampling plan outlined in Table 1, a specified number of samples were reprocessed by QC inspectors with expertise in the task being inspected. In cases where a sample was subdivided and counted, counts for all subdivisions were combined before calculating percent error for that sample. If the difference between the QC value and the original value exceeded acceptable tolerances (Table 1), a third measurement could be obtained to verify one of the measurements. If a sample from the block of 1 out of 7 samples (*f*) was found to have exceeded acceptable tolerances, all samples within that block were subjected to review to ensure that the quality meets acceptable tolerance levels. Furthermore, all subsequent samples processed by the same technician were subjected to 100% QC until 8 consecutive samples (*i*) were found within acceptable tolerance limits as determined by the continuous sampling plan (Table 1 and Figure 1). The Quality Assurance plan (Normandeau 2014) documents specific QA/QC methods utilized for this program.

Table 1. Task specific applications of continuous sampling plans for the 2014 Hudson River Ichthyoplankton Laboratory Program.

Laboratory Task	CSP-1 AOQL 10%		Sample Tolerance	QC Sample Definition
	i*	f**		
Sorting	8	1/7	± 2 organisms if ≤20 organisms ± 10% if >20 organisms	one sample
Identification	8	1/7	± 2 organisms if ≤20 organisms ± 10% if >20 organisms for every taxon in the sample (in identifying, assigning a life stage, or counting any species, errors are cumulative by life stage within each taxon)	one sample

* "*i*" = number of samples within the 100% sample inspection training period

** "*f*" = fraction of samples randomly selected for QC

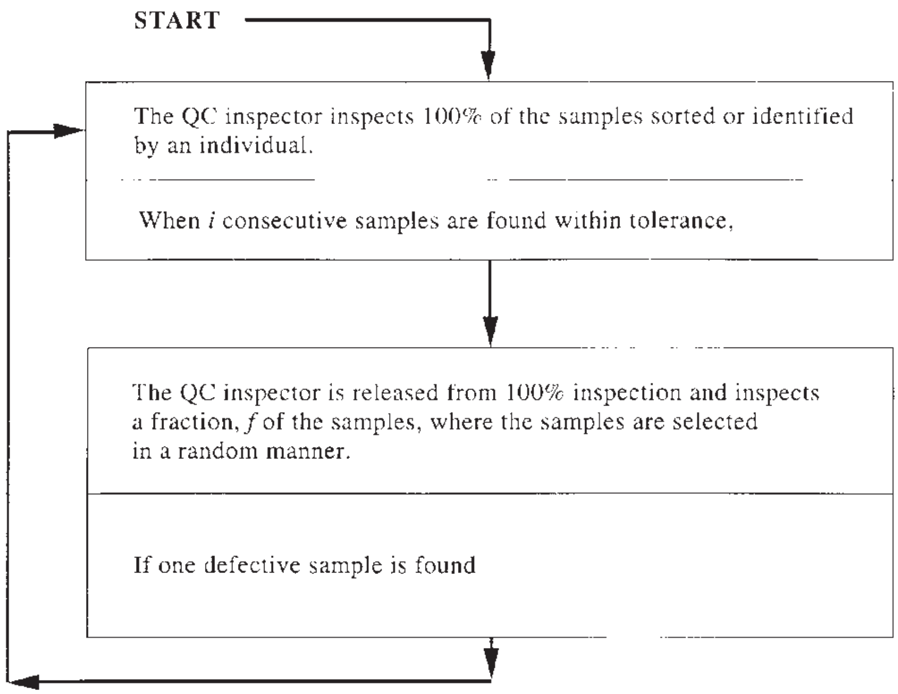

Figure 1. Quality control inspection plan for ichthyoplankton sorting and identification tasks.

In some cases, one of the taxonomists (either the original identifier or the QC inspector) was able to determine the taxon or life stage of damaged specimens when the other taxonomist recorded them as unknown life stage, unidentified taxon, or a higher level taxon (genus or family). If a more general taxon or life stage used by one taxonomist *included* the more specific category used by the other taxonomist and was only separated by one consecutive taxonomic level such as Family-Genus or Genus-Species, and that was the only reason for a count discrepancy, then that sample was not considered failing the QC inspection. For example, damaged specimens recorded as *Morone* sp. (Genus level) by the original identifier and as *Morone saxatilis* (Species level) by the QC inspector were considered to be in agreement because the category *Morone* sp. includes *Morone saxatilis*. In contrast, an original determination of unidentified Gobiidae (Family) would not be acceptable if the QC determination was *Morone saxatilis* (Species), because 1) taxonomically, *Morone saxatilis* is not in the family Gobiidae and 2) *M. saxatilis* is more than one taxonomic level separated from the family Gobiidae.

2.1.2 Fall Juvenile and Beach Seine Surveys

The Fall Juvenile Survey, also historically referred as Fall "Shoals" Survey, consisted of collections from two gear types, a 3-m wide x 0.9 m high beam trawl (3.2 cm stretch mesh codend and 1.3 cm stretch mesh liner) and 1-m^2 Tucker trawl (2.0 mm mesh net). Juvenile fish are also sampled along the shore by the Beach Seine Survey, which uses a 2.4-m high seine with two 12-m long wings of 1.0-cm bar mesh and 0.5-cm bar mesh bag. For laboratory identification and length measurements of young-of-the-year fishes in the 2014 Fall Juvenile Survey, Normandeau used a continuous sampling plan designed to provide a 10% Average Outgoing Quality Limit (U.S. Department of Defense, 1981). A flow diagram of how the plan was applied is presented in Figure 2.

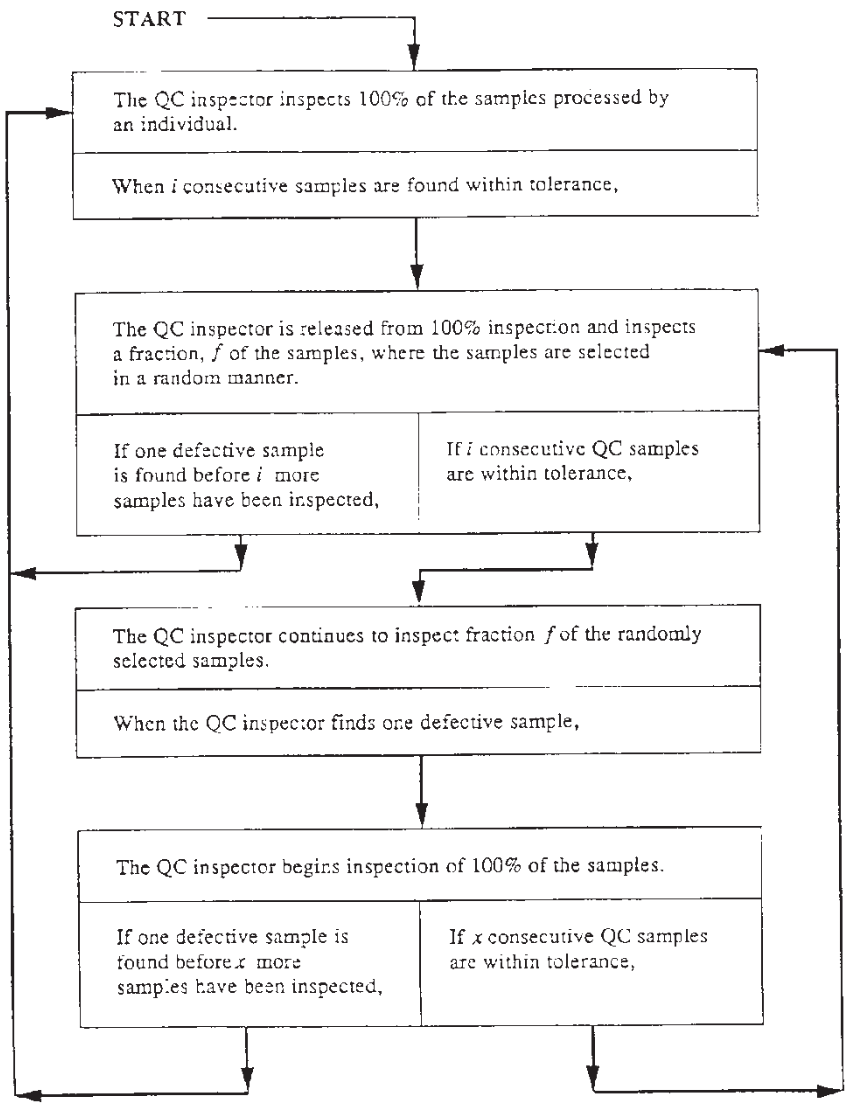

Figure 2. Quality control inspection plan for identification and length measurement of young-of-the-year fishes.

A summary of the sampling plan, tolerances, and QC sample definitions used for each task is shown in Table 2. QC samples were selected as specified by the appropriate plan in Table 2, using random numbers, and reprocessed by QC inspectors. If the difference between original and QC values exceeded the acceptable tolerance, a third value was obtained as a resolution. The standard operating procedures manual (Normandeau 2013) documents specific QA/QC methods used for the 2014 Fall Juvenile and Beach Seine Surveys. Young-of-the-year fishes were identified in the laboratory for the first two Fall Juvenile Survey "River Runs" (sampling weeks) and the first three Beach Seine Survey River Runs. Young-of-the-year fishes were identified in the field starting with Fall Juvenile Survey River Run 3 and Beach Seine Survey River Run 4. The same QC procedures applied to both field and laboratory identifications. All length measurements of young-of-the-year fishes occurred in the laboratory.

Table 2. Task specific applications of continuous sampling plans for the 2014 Fall Juvenile Survey.

Task	QC Plan	AOQL	*i**	*f***	x	Tolerance	QC Sample Definition
Identification	CSP-V	7%	21	1/15	7	±10% of total count or ±2 individuals when <25 fish	One taxon
Length	CSP-V	7%	30	1/50	10	±1 mm when <34 mm TL ±3% when >34 mm TL	One fish

* "*i*" = number of samples within the 100% sample inspection training period

** "*f*" = fraction of samples randomly selected for QC

2.2 Reporting Procedures

The 2014 Hudson River Ichthyoplankton Laboratory Program Sort and Identification QC Logs were keyed, verified, and error-checked to produce SAS data sets. From these data, percent inspected, percent nonconforming, and percent error (precision) were determined for each River Run and for the entire study. For the 2014 Fall Juvenile Survey, QC data were used to determine percent inspected and percent nonconforming for the entire study (combining all River Runs processed in the laboratory for both the Fall Juvenile Survey and the Beach Seine Survey).

2.2.1 Percent Inspected

Percent Inspected

$$= \frac{Number\ of\ Samples\ Inspected}{Total\ Number\ of\ Samples\ Analyzed}\ x\ 100 \qquad \text{(Equation 1)}$$

River Run: Percent inspected (%) for a River Run (Equation 1) was the number of samples inspected divided by the total number of samples analyzed for that River Run times one hundred. For the ichthyoplankton sorting task, the number of samples inspected excludes "training QC samples" for new sorters, which do not represent the independent performance of the technician, as well as the samples inspected as part of the QC plan. For the identification task, the total number of samples identified excludes empty ("no catch") samples, which did not require processing by an identifier.

Entire Study: Percent inspected for the entire study was the number of samples inspected divided by the total number of samples analyzed times one hundred during the study.

2.2.2 Percent Nonconforming

Percent Nonconforming

$$= \frac{Number\,of\;Nonconforming\;Quality\;Control\;Samples\;Inspected}{Total\;Number\,of\;Quality\;Control\;Samples\;Inspected}\;x\;100$$

(Equation 2)

River Run: Percent nonconforming for a River Run (Equation 2) was the number of nonconforming QC samples found for that River Run divided by the total number of QC samples inspected times one hundred for that River Run.

Entire Study: Percent nonconforming for the entire study was the total number of nonconforming QC samples for the study divided by the total number of QC samples inspected times one hundred for the study. The result of this analysis was a determination of the actual incoming quality level of each measurement parameter. (Note that because samples checked by QC found to be defective were rectified during QC, the average outgoing quality of the final data set was better than that indicated by the percent nonconforming.)

2.2.3 Percent Error

Sorting Task

Sorting Percent Error

$$= \frac{Quality\;Control\;Count}{(Original\;Count + Quality\;Control\;Count)}\;x\;100$$

(Equation 3)

Sample: Percent error for a sorted sample (Equation 3) was the QC count divided by the sum of the original count and the QC count (adjusted total) times one hundred. The denominator is an adjusted total because the sorting procedure is the initial process by which all countable organisms are removed from the field sample. Therefore, if QC personnel have found additional organisms that the original sorter missed, then the total count must reflect this addition to the sample total. The sorting task is not life stage or taxon specific, it is the total count of all countable organisms sorted. Refer to Table 3 for an example of this sample percent error calculation.

River Run: Mean percent error for sorted samples for a River Run was the sum of the percent errors for each sample inspected during the River Run divided by the total number of samples inspected for the River Run times one hundred.

Entire Study: Mean percent error for sorted samples for the entire study was the sum of the percent measurement errors for each sample inspected during the study divided by the total number of samples inspected for the study times one hundred. (Note that this method of averaging gives equal weight to each sample, regardless of the number of organisms present).

Identification Task

Life Stage Percent Error

$$= \frac{(Original\,Count - Quality\,Control\,Count)}{Quality\,Control\,Count}\ x\ 100 \qquad \text{(Equation 4)}$$

Life Stage: Percent error for a life stage (Equation 4) was the difference between the original life stage count and the QC life stage count divided by the QC life stage count times one hundred.

Exceptions to Equation 4:

1) For life stages where the QC count was 20 individuals or less and the original and QC counts differed by no more than two organisms, the percent error was defined as +/- 1 or 2. For life stages where the QC value was 20 or less and the original and QC values differed by more than two organisms, the percent error was calculated utilizing Equation 4. Refer to Table 3 for an example of this life stage percent error calculation exception.
2) If the QC count was zero, the percent error will be 100%. This error was calculated by dividing the difference between the original count and the QC count by the original count times one hundred. Refer to Table 3 for an example of this QC=0 percent error calculation exception.

If the sample fails then a resolution by a third party must occur. Percent error will then be recalculated for the QC counts and the original counts but by using Equation 4 but using the Resolution Counts as the denominator. Then, if the original count for a life stage was acceptably close (within 10%) to a resolution value but not to the QC value, the original counts are not to be changed and the samples passes. If the original counts are not within 10% from the resolution count then the sample fails and the original data counts are replaced by the QC counts. During the rare occurrence that the original values are greater than 10% from the resolution and the QC counts, then the sample will be reanalyzed by all three people and the identifier's sample processing will not continue until agreement can be reached on the identification of the sample.

Taxon: Percent error for an identified taxon was the sum of the absolute values of percent error for each life stage within the taxon. Refer to Table 3 for an example of taxon percent error calculations.

Table 3. Examples of percent error calculations for individual taxa and samples during both the identification and sorting tasks.

		Eggs	Yolk-Sac Larvae	Post Yolk-Sac Larvae	Total
Sorting Task Example:					
Sample Error					
	Original Count	250	52	351	653
	Quality Control Count	3	0	5	8
	% Error by Sample				1.2%
Identification Task Examples:					
Taxon 1					
	Original Count	103	186	31	
	Quality Control Count	100	194	26	
	% Error by Life Stage	3.0%	4.1%	5.2%	12.3%
Taxon 2					
	Original Count		15		
	Quality Control Count		13		
	% Error by Life Stage		+/- 2		+/- 2
Taxon 3					
	Original Count		8		
	Quality Control Count		2		
	% Error by Life Stage		300%		300%
Taxon 4					
	Original Count	25	20	2	
	Quality Control Count	25	0	22	
	% Error by Life Stage		100%	10%	110%

River Run: Mean percent error for the identification task for a River Run was the sum of the percent measurement errors for all taxa inspected during the River Run divided by the total number of taxa inspected for the River Run. This statistic was computed by averaging taxa rather than samples because even though complete samples were inspected and reworked for identification QC, the pass/fail criterion was whether any taxon in the sample individually exceeded the 10% tolerance.

Entire Study: Mean percent error for identified taxa for the entire study was the sum of the percent errors for all taxa inspected during the study divided by the total number of taxa inspected for the study.

2.2.4 Average Outgoing Quality

At the completion of these studies, the Average Outgoing Quality (AOQ) was calculated for each measurement parameter inspected. Continuous sampling plans were used for all tasks. Continuous sampling plans are devised for processes involving a continuous or nearly continuous flow of products or other entities. For these types of processes, it is extremely difficult to organize units into discrete groups commonly referred to as lots. As a result, inspection must be performed on individual units drawn from a continuous flow of products and a decision made concerning the quality of units produced based on the inspection results. Rectification is performed on any nonconforming unit found during inspection, followed by 100% screening of a number of subsequent units depending on the sampling plan. Average Outgoing Quality for each laboratory task was calculated as a function of the percent nonconforming and the fraction of total units inspected (Stephens 1979). This calculation applies to continuous sampling plans when nonconforming units found are rectified:

$$AOQ = \frac{p'(1-f)q^i}{f+(1-f)q^i} \times 100 \qquad \text{(Equation 5)}$$

where

p' = Percent nonconforming as a decimal fraction
f = Proportion of units inspected. This is a parameter of the sampling plan.
q = 1-p' = Percent conforming as a decimal fraction
i = Clearing interval. This is a parameter of the sampling plan.

Example:

p' = 0.0689
f = 1/7 = 0.1429
q = 1-0.0689 = 0.9311
i = 8

$$AOQ = \frac{0.0689(1-0.1429)(0.9311)^8}{0.1429+(1-0.1429)(0.9311)^8} \times 100 = 5.32\%$$

The above equation for calculating AOQ was formulated specifically for CSP-1 sampling plans such as those used for the ichthyoplankton sorting and identification (Table 1). The same equation was used to calculate AOQ for young-of-the-year identifications and measurements, which used CSP-V plans (Table 2). When Equation 5 is used for CSP-V plans, the calculated AOQ is conservatively high, because the equation does not take into account the times when the number of consecutive re-inspections following a failure is x (which is smaller than i).

2.2.5 Cumulative Error Rates

Due to the non-independence of identification errors across taxa and life stages, and to the accumulation of errors within taxa, a relatively high fraction of samples may fail QC inspection even though only a small fraction of organisms are incorrectly identified or counted. In order to present the error frequencies more realistically for particular taxa-life stages, two additional statistics were calculated for each taxon-life stage for the identification/counting process.

Absolute Error Rate =

$$\sum_{i=1}^{n} | I_i - Q_i | / \sum_{i=1}^{n} Q_i \qquad \text{Equation 6}$$

Net Error Rate =

$$\sum_{i=1}^{n} (I_i - Q_i) / \sum_{i=1}^{n} Q_i \qquad \text{Equation 7}$$

where

I_i = initial count for taxon-life stage in sample i
Q_i = QC count for taxon-life stage in sample i (or the resolution count, if I_i was acceptably close to it but not to the QC count)
n = number of samples in the entire study

If the sum of Q_i for the entire study was zero for the taxon-life stage, then the sum of Q_i was set equal to one for the purpose of calculating absolute and net error rate.

The absolute error rate is the approximate fraction of the taxon-life stage that was originally identified or counted incorrectly. This is an estimate of the fraction of erroneous countable items in the uninspected samples.

Net error rate is the approximate relative error in the total counts for the taxon-life stage. For this index, positive (original count too high) and negative (original count too low) errors cancel each other so that the index reflects the relative net bias to the taxon-life stage abundance.

3.0 Results

3.1 Ichthyoplankton Laboratory Program

The Average Outgoing Quality (AOQ) of the 2014 Hudson River Ichthyoplankton Laboratory Program was 4.41% for the sorting task and 0.58% for the identification task. These AOQ levels represent the actual or achieved quality for measurement parameters and were within the 10% AOQL requirement of the study. The average of the Percent Inspected among River Runs was 27.60% for the sorting task and 15.69% for the identification task (Table 4).

Table 4. Average percent inspected, percent nonconforming, mean percent error, and average outgoing quality (AOQ) of tasks performed by Normandeau for the 2014 Hudson River Ichthyoplankton Laboratory Program.

Task	Percent Inspected (%)	Percent Nonconforming (%)	Mean Percent Error (%)	AOQ (%)
Sorting	27.60	5.57	1.95	4.41
Identification	15.69	0.68	4.65	0.58

Sorting and identification tasks were also evaluated on the basis of River Runs (sampling weeks). Sorted samples were inspected at a rate of 11.11% to 45.24% for individual River Runs (Table 5). Nonconformance for the sorting task among the inspected samples ranged from 0% to 21.05% in the 20 River Runs (Table 6). Sorting error ranged between 0.14% and 6.79% (Table 7). For the task of sample identification, 11.54% to 32.10% of samples were inspected from individual River Runs (Table 8). Percent nonconforming for the identification task in individual River Runs ranged from 0% to 3.85% (Table 9). Percent error for individual River Runs ranged from 0% to 30.28% (Table 10).

Percent error results for the identification task are skewed towards high values as a result of the method of computation at the life stage level. In addition, errors are summed over life stages within each taxon, which then amplifies the already skewed life stage values. These data are not indicative of actual error and should only be compared to other error results that are calculated using exactly the same methods. In all cases of failed QC samples, the data were corrected and the QC sample inspection frequency was maintained at 100% for that individual until acceptable results were demonstrated as determined by the QC sampling plan.

Table 5. Sample sorting percent inspected results, 2014 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total # of Samples Inspected	Total # of Samples Sorted	Percent Inspected (%)
31 Mar 14	53	126	42.06
07 Apr 14	52	126	41.27
14 Apr 14	41	126	32.54
21 Apr 14	29	135	21.48
28 Apr 14	23	135	17.04
05 May 14	30	135	22.22
12 May 14	38	126	30.16
19 May 14	57	126	45.24
26 May 14	52	126	41.27
02 Jun 14	43	122	35.25
09 Jun 14	35	123	28.46
16 Jun 14	32	123	26.02
23 Jun 14	27	123	21.95
07 Jul 14	12	81	14.81
21 Jul 14	9	75	12.00
04 Aug 14	12	78	15.38
18 Aug 14	9	81	11.11
01 Sep 14	27	81	33.33
15 Sep 14	11	81	13.58
29 Sep 14	18	81	22.22
Study	**610**	**2210**	**27.60**

Table 6. Percent nonconformance of samples inspected during the sorting procedure, 2014 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Number of Nonconformities	Total No. of Samples Inspected	Percent Nonconformance
31 Mar 14	2	53	3.77
07 Apr 14	1	52	1.92
14 Apr 14	1	41	2.44
21 Apr 14	0	29	0.00
28 Apr 14	0	23	0.00
05 May 14	2	30	6.67
12 May 14	3	38	7.89
19 May 14	12	57	21.05
26 May 14	1	52	1.92
02 Jun 14	2	43	4.65
09 Jun 14	5	35	14.29
16 Jun 14	0	32	0.00
23 Jun 14	2	27	7.41
07 Jul 14	0	12	0.00
21 Jul 14	0	9	0.00
04 Aug 14	0	12	0.00
18 Aug 14	0	9	0.00
01 Sep 14	3	27	11.11
15 Sep 14	0	11	0.00
29 Sep 14	0	18	0.00
Study	**34**	**610**	**5.57**

Table 7. Mean percent error for the sorting procedure by sampling week, 2014 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total No. of Samples Inspected	Mean Percent Error
31 Mar 14	53	1.58
07 Apr 14	52	0.30
14 Apr 14	41	0.80
21 Apr 14	29	0.58
28 Apr 14	23	0.19
05 May 14	30	1.86
12 May 14	38	2.45
19 May 14	57	6.79
26 May 14	52	1.78
02 Jun 14	43	1.17
09 Jun 14	35	2.89
16 Jun 14	32	0.85
23 Jun 14	27	3.04
07 Jul 14	12	2.27
21 Jul 14	9	0.78
04 Aug 14	12	0.85
18 Aug 14	9	2.49
01 Sep 14	27	2.36
15 Sep 14	11	1.33
29 Sep 14	18	0.14
Study	**610**	**1.95**

Table 8. Percent of samples inspected during the identification procedure, 2014 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total No. of Samples Inspected	Total No. of Samples Identified	Percent Inspected
31 Mar 14	10	61	16.39
07 Apr 14	8	52	15.38
14 Apr 14	7	52	13.46
21 Apr 14	10	67	14.93
28 Apr 14	14	98	14.29
05 May 14	18	125	14.40
12 May 14	18	124	14.52
19 May 14	18	126	14.29
26 May 14	17	126	13.49
02 Jun 14	17	122	13.93
09 Jun 14	21	123	17.07
16 Jun 14	26	123	21.14
23 Jun 14	16	123	13.01
07 Jul 14	12	81	14.81
21 Jul 14	11	75	14.67
04 Aug 14	9	78	11.54
18 Aug 14	13	81	16.05
01 Sep 14	11	81	13.58
15 Sep14	13	81	16.05
29 Sep 14	26	81	32.10
Study	**295**	**1880**	**15.69**

Table 9. Sample identification percent nonconformance results, 2014 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Number of Nonconformities	Total No. of Samples Inspected	Percent Nonconformance (Week)
31 Mar 14	0	10	0.00
07 Apr 14	0	8	0.00
14 Apr 14	0	7	0.00
21 Apr 14	0	10	0.00
28 Apr 14	0	14	0.00
05 May 14	0	18	0.00
12 May 14	0	18	0.00
19 May 14	0	18	0.00
26 May 14	0	17	0.00
02 Jun 14	0	17	0.00
09 Jun 14	0	21	0.00
16 Jun 14	1	26	3.85
23 Jun 14	0	16	0.00
07 Jul 14	0	12	0.00
21 Jul 14	0	11	0.00
04 Aug 14	0	9	0.00
18 Aug 14	0	13	0.00
01 Sep 14	0	11	0.00
15 Sep 14	0	13	0.00
29 Sep 14	1	26	3.85
Study	**2**	**295**	**0.68**

Table 10. Mean percent error of samples inspected during the identification procedure, 2014 Hudson River Ichthyoplankton Laboratory Program.

Sampling Week (Beginning Monday)	Total No. of Samples Inspected	Mean Percent Error	Number of Taxa Inspected
31 Mar 14	10	0.00	12
07 Apr 14	8	0.00	15
14 Apr 14	7	0.00	11
21 Apr 14	10	0.15	19
28 Apr 14	14	0.02	27
05 May 14	18	0.18	35
12 May 14	18	0.11	63
19 May 14	18	0.47	76
26 May 14	17	0.76	74
02 Jun 14	17	0.71	95
09 Jun 14	21	0.43	108
16 Jun 14	26	30.28	163
23 Jun 14	16	0.45	88
07 Jul 14	12	0.38	63
21 Jul 14	11	0.31	54
04 Aug 14	9	0.11	52
18 Aug 14	13	0.13	49
01 Sep 14	11	0.02	37
15 Sep 14	13	0.00	47
29 Sep 14	26	1.36	59
Study	**295**	**4.65**	**1147**

Additional organisms found during the sort QC were identified independently to determine the frequency of species and life stages missed during the initial sort. Six taxa accounted for 92% of the additional organisms found during sort QC: Striped Bass, White Perch, Herring family, Bay Anchovy, *Morone* sp., and Goby family (Table 11). For these six taxa, the additional number of organisms per stage found in the sort QC amounted to less than 2% of the total found during sample processing. Exceptions of >2% were within the most abundant life stage: Bay Anchovy yolk-sac larvae (2.83%), Goby family eggs (100%) and yolk-sac larvae (25%), Herring unidentifiable stage (16.13%), *Morone* species unidentifiable stage (2.59%), Striped Bass eggs (2.93%) and unidentifiable stage (7.62%) and, White Perch eggs (6.84) and yolk-sac larvae (2.24%; Table 12). For most taxa by life stage, the percentage missed by the original sorter was well under 5%.

During the identification process, absolute error rates for individual life stages of commonly encountered taxa were usually less than 0.02. Generally, only those taxa-life stages with low total counts had absolute error rates above 0.05 (Table 13).

Net error rates were substantially lower than the absolute error rates in most cases, demonstrating that errors often tended to cancel each other out. This was especially noticeable for many of the most abundant taxa-life stages, such as Bay Anchovy eggs and Striped Bass yolk-sac and post yolk-sac larvae.

3.2 Fall Juvenile Survey

Results of the laboratory QC program for the 2014 Fall Juvenile Survey (consisting of the Beach Seine Survey and the Fall Shoals Survey) were summarized by the same methods as the QC results for the 2014 Hudson River Ichthyoplankton Laboratory Program and are presented in Table 14.

There were 1,213 and 847 young-of-the-year fish identification records made in the laboratory for the Fall Juvenile and Beach Seine surveys respectively and 7,588 and 4,923 young-of-the-year fish length measurement records were made for the Fall Juvenile and Beach Seine surveys respectively.

Table 11. Ranking of ichthyoplankton taxa missed during initial sort and found during sort Quality Control (QC), 2014 Hudson River Ichthyoplankton Laboratory Program.

Taxon	Number of Organisms found in Sort QC	Percent
Striped Bass	2196	47.55
White Perch	904	19.58
Herring family	627	13.58
Bay Anchovy	305	6.60
Morone species	111	2.40
Unidentified	110	2.38
Goby family	96	2.08
Atlantic Tomcod	64	1.39
Winter Flounder	58	1.26
Cunner	37	0.80
Tautog	24	0.52
Freshwater Drum	22	0.48
Hogchoker	14	0.30
Windowpane	11	0.24
Atlantic Croaker	9	0.19
Atlantic Menhaden	9	0.19
Gizzard Shad	6	0.13
American Shad	3	0.06
American Sand Lance	2	0.04
Inland Silverside	2	0.04
American Eel	1	0.02
Carp and Minnow family	1	0.02
Common Carp	1	0.02
Summer Flounder	1	0.02
Sunfish family	1	0.02
Tessellated Darter	1	0.02
Weakfish	1	0.02
Yellow Perch	1	0.02
Total	**4618**	**100.00**

Table 12. Summary of ichthyoplankton by life stage for the six highest ranked taxa missed during original sort and found during sort QC compared to total count, 2014 Hudson River Ichthyoplankton Laboratory Program.

Taxon	Life Stage	Percent of Abundance Each by Life Stage	Number Missed in Original Sort	Total Organisms Found [a]	Percent of Total Found During QC
Bay Anchovy	Eggs	44.26	135	35421	0.38
	Yolk-sac larvae	0.98	3	106	2.83
	Post yolk-sac larvae	54.75	167	19551	0.85
	Young-of-the-year	0	0	9436	0
	Unidentified	0	0	27	0
Goby family	Eggs	4.17	4	4	100
	Yolk-sac larvae	2.08	2	8	25
	Post yolk-sac larvae	93.75	90	8095	1.11
	Unidentified	0	0	1	0
Herring family	Eggs	13.08	82	12980	0.63
	Yolk-sac larvae	7.97	50	6075	0.82
	Post yolk-sac larvae	78.15	490	36086	1.36
	Unidentified	0.8	5	31	16.13
Morone species	Yolk-sac larvae	0	0	11	0
	Post yolk-sac larvae	82.88	92	4940	1.86
	Unidentified	17.12	19	733	2.59
Striped Bass	Eggs	57.7	1267	43186	2.93
	Yolk-sac larvae	22.22	488	36314	1.34
	Post yolk-sac larvae	19.31	424	181809	0.23
	Young-of-the-year	0.05	1	984	0.1
	Unidentified	0.73	16	210	7.62
White Perch	Eggs	33.08	299	4374	6.84
	Yolk-sac larvae	16.92	153	6840	2.24
	Post yolk-sac larvae	50	452	28617	1.58
	Young-of-the-year	0	0	127	0
	Unidentified	0	0	13	0

[a] Includes both original count and additional organisms found during sort QC.

Table 13. Cumulative net and absolute error rates for commonly encountered taxa in ichthyoplankton samples selected for QC inspection of identification process, 2014 Hudson River Ichthyoplankton Laboratory Program.

Taxon	Stage	Total Count	Net Error	Absolute Error	No. Samples
Atlantic Croaker	Post Yolk Sac Larvae	1029	0.00389	0.00389	31
	Young Of The Year	54	-0.07407	0.07407	9
Atlantic Menhaden	Eggs	185	0.00000	0.00000	8
	Yolk-Sac Larvae	7	0.00000	0.00000	4
	Post Yolk Sac Larvae	35	1.34286	1.34286	18
	Young Of The Year	6	0.16667	0.16667	5
Atlantic Tomcod	Unidentified	12	0.00000	0.00000	3
	Yolk-Sac Larvae	27	0.03704	0.03704	8
	Post Yolk Sac Larvae	851	0.00118	0.00353	29
	Young Of The Year	1118	-0.00089	0.00089	74
Bay Anchovy	Unidentified	6	0.00000	0.00000	5
	Eggs	7364	0.00326	0.00598	52
	Yolk-Sac Larvae	18	0.05556	0.05556	6
	Post Yolk Sac Larvae	3208	-0.01527	0.02276	113
	Young Of The Year	1150	0.00348	0.00522	69
Blueback Herring	Young Of The Year	736	0.00000	0.00272	25
Freshwater Drum	Eggs	1209	0.00083	0.00083	10
	Yolk-Sac Larvae	4	0.25000	0.25000	5
	Post Yolk Sac Larvae	42	0.02381	0.02381	11
Goby family	Unidentified	1	0.00000	0.00000	1
	Post Yolk Sac Larvae	1357	-0.00221	0.00958	56
Herring family	Unidentified	1	0.00000	0.00000	1
	Eggs	1812	0.00386	0.00497	28
	Yolk-Sac Larvae	1002	0.00399	0.01198	44
	Post Yolk Sac Larvae	5001	-0.00100	0.01380	130
Hogchoker	Eggs	744	0.00134	0.00941	15
	Yolk-Sac Larvae	13	-0.07692	0.07692	8
	Post Yolk Sac Larvae	15	-0.06667	0.06667	8
	Young Of The Year	6	0.50000	0.50000	5
***Morone* species**	Unidentified	36	0.08333	0.13889	11
	Post Yolk Sac Larvae	361	0.06925	0.08033	30
Striped Bass	Unidentified	44	-0.02273	0.11364	8
	Eggs	6499	-0.00015	0.00077	52
	Yolk-Sac Larvae	4757	0.00399	0.01577	67
	Post Yolk Sac Larvae	19207	-0.00193	0.00869	109
	Young Of The Year	91	-0.01099	0.01099	28
Tautog	Eggs	604	-0.00331	0.00993	11
	Post Yolk Sac Larvae	3	0.33333	0.33333	3

(continued)

Table 13. (Continued)

Taxon	Stage	Total Count	Net Error	Absolute Error	No. Samples
White Perch	Eggs	170	-0.01176	0.02353	22
	Yolk-Sac Larvae	643	0.00467	0.01089	41
	Post Yolk Sac Larvae	2182	0.00962	0.03437	80
	Young Of The Year	42	0.00000	0.00000	7
Winter Flounder	Yolk-Sac Larvae	37	0.00000	0.00000	6
	Post Yolk Sac Larvae	265	0.00000	0.00000	16
	Young Of The Year	2	0.00000	0.00000	2

Table 14. Percent inspected, percent nonconforming, and average outgoing quality of laboratory tasks for the 2014 Fall Juvenile and Beach Seine Surveys.

Task	Percent Inspected (%)	Percent Nonconforming (%)	Average Outgoing Quality (%)
Identification	6.26	0.00	0.00
Measurement	1.92	0.00	0.00

4.0 Literature Cited

Normandeau Associates Inc. 2013. 2013 Hudson River fall juvenile and beach seine surveys standard operating procedures. June 2013. Prepared for Indian Point Energy Center.

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