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Kepone in the James River Estuary: Past, Current and Future Trends

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KEPONE IN THE JAMES RIVER ESTUARY: PAST, CURRENT AND FUTURE TRENDS

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Executive Summary

In late 1975, a manufacturing facility in Hopewell, VA had not only exposed workers to the chlorinated pesticide, Kepone, but had also severely contaminated the James River estuary. To assess the potential risk to the public, Virginia initiated a finfish-monitoring program in late 1975. Over the next 40 years over 13,000 samples were collected from the James River and Chesapeake Bay and analyzed for Kepone. Kepone production was eventually banned worldwide. The average Kepone concentrations found in most species began falling when the production of Kepone ended, but the averages remained over the action limit of 0.3 $mgkg^{-1}$ until the early 1980s. By 1988, few fish contained average Kepone concentrations greater than the action limit. Kepone was still detected (>0.01 $mgkg^{-1}$ wet weight) in the majority of white perch and striped bass samples taken from the James River in 2009 and a fish consumption advisory is still in effect over forty years after the source of contamination was removed.

Due to state budget cuts, monitoring of Kepone has not been conducted since 2009. As part of its 40th Anniversary, the Virginia Environmental Endowment -- which was established as part of the Kepone pollution court settlement in 1977 -- requested that VIMS conduct an updated study of the current levels of Kepone in the James River. The VIMS analysis of 85 samples of striped bass and white perch collected in 2016 showed that 35% of the samples were below the detection limit and average Kepone concentrations are now 0.015-0.030 $mgkg^{-1}$ in samples with measurable levels, well below the action limit of 0.3 $mgkg^{-1}$. However, approximately 65% of the fish analyzed still have reportable concentrations of Kepone more than 40 years after the event was first discovered which indicates the persistence of the chemical and how difficult it is to rid a system of a persistent toxic chemical. The good news is that overall the Kepone in fish tissues is continuing to decline exponentially since 1980 and should be near the detection limit (0.01 $mgkg^{-1}$) by 2020-2025 if the current trends continue. Additional monitoring is encouraged by 2025 to verify if the downward trends continue and may be warranted sooner if dredging or other activities disturb contaminated sediments locally, although it is unlikely that limited dredging would have a prolonged or widespread effect of increasing fish tissue concentrations throughout the river like decades ago. There has also been some concern that a hurricane might disturb sediments in the James River and cause a recontamination of the food chain and once again bring increased risk from Kepone to fish consumers. However, since hurricane events are typically accompanied by large amounts of rainfall, flooding and increased runoff and suspended sediment into receiving waters, this increased sediment load should have the opposite effect and not expose old Kepone deposits. Finally, the question has arisen as to whether another Kepone incident could occur. The potential for identifying new emerging contaminants still exists and may be more important as the trend of increasing production of new drugs and chemicals that can enter our waters continues. However, funding for Virginia’s toxics monitoring program has diminished in recent years and become more focused on specific contaminants already regulated while the analysis of unidentified compounds may go unnoticed.

Background-Kepone is a historically important anthropogenic contaminant that was first introduced to the aquatic environment of Chesapeake Bay over 35 years ago. In late 1975, it was discovered that a manufacturing facility had not only exposed workers to the chlorinated pesticide, Kepone, but had also severely contaminated the James River estuary (Huggett and Bender, 1980). To assess the potential for the public to be exposed to Kepone through the consumption of contaminated seafood, the Commonwealth of Virginia initiated a finfish-monitoring program in late 1975 (Luellen et al, 2006). Over 13,000 samples had been collected from various zones in the James River and Chesapeake Bay and analyzed as part of this effort (Figure 1). Kepone

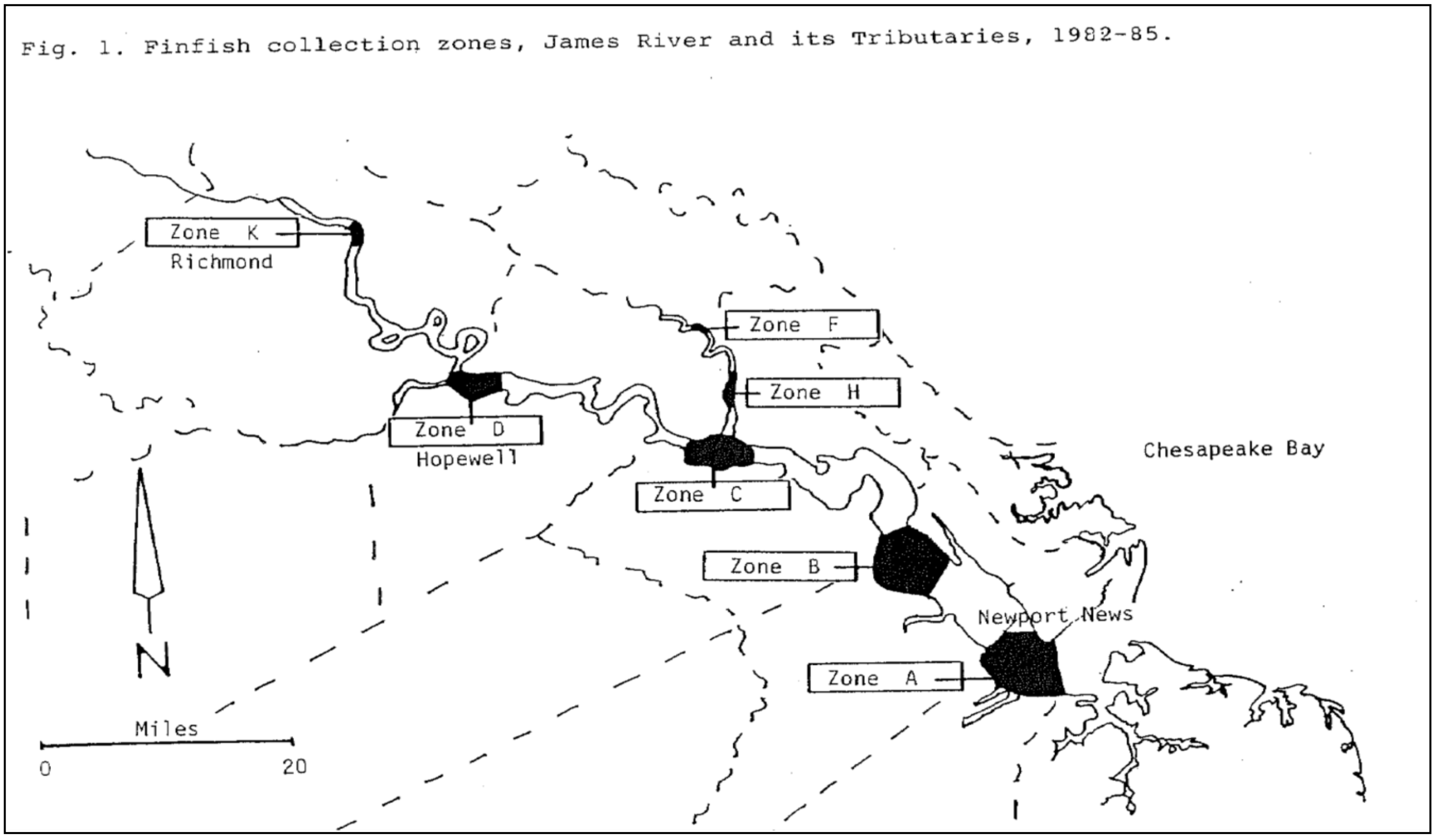

Figure 1. Zones used for fish tissue monitoring program

concentrations found in most species began falling when the production of Kepone ended, but the averages remained over the action limit of 0.3 mg g^{-1} wet weight until the early 1980s (Luellen et al., 2006). Although the average concentrations of Kepone in fish species populations did not exceed the action limit, Kepone concentration levels in individual fish (i.e. white perch) continued to exceed the action level until the year 2000 (Figure 2). Kepone was still detected (>0.01 $mgkg^{-1}$ wet weight) in the majority of white perch and striped bass samples taken from the James River in 2009 and a fish consumption advisory is still in effect 40 years after the source of contamination was removed. However, an additional separate advisory is now also in place for PCBs in the same region of the James River that is more restrictive than the current Kepone advisory. Due to budget cuts, no Kepone monitoring had occurred since the last fish samples collected by VADEQ and analyzed by VIMS took place in 2009. The current status of Kepone concentrations in James River fish was unknown until this study was initiated in 2016 at the request of the Virginia Environmental Endowment in conjunction with the 40th anniversary of its establishment as part of the settlement of the Kepone Clean Water Act case.

Project Objective- Current Kepone Concentrations: We proposed to collect and analyze up to 85 samples of striped bass and white perch from Zone C in the James River in 2016 to evaluate the current Kepone contamination status in these important food fish. Zone C has been shown to be the area with some of the highest historical Kepone concentrations relative to other regions in the James River (Huggett and Bender, 1980; Luellen et al., 2006). These new data will be compared to historical concentration information for the same region and species to document any trends.

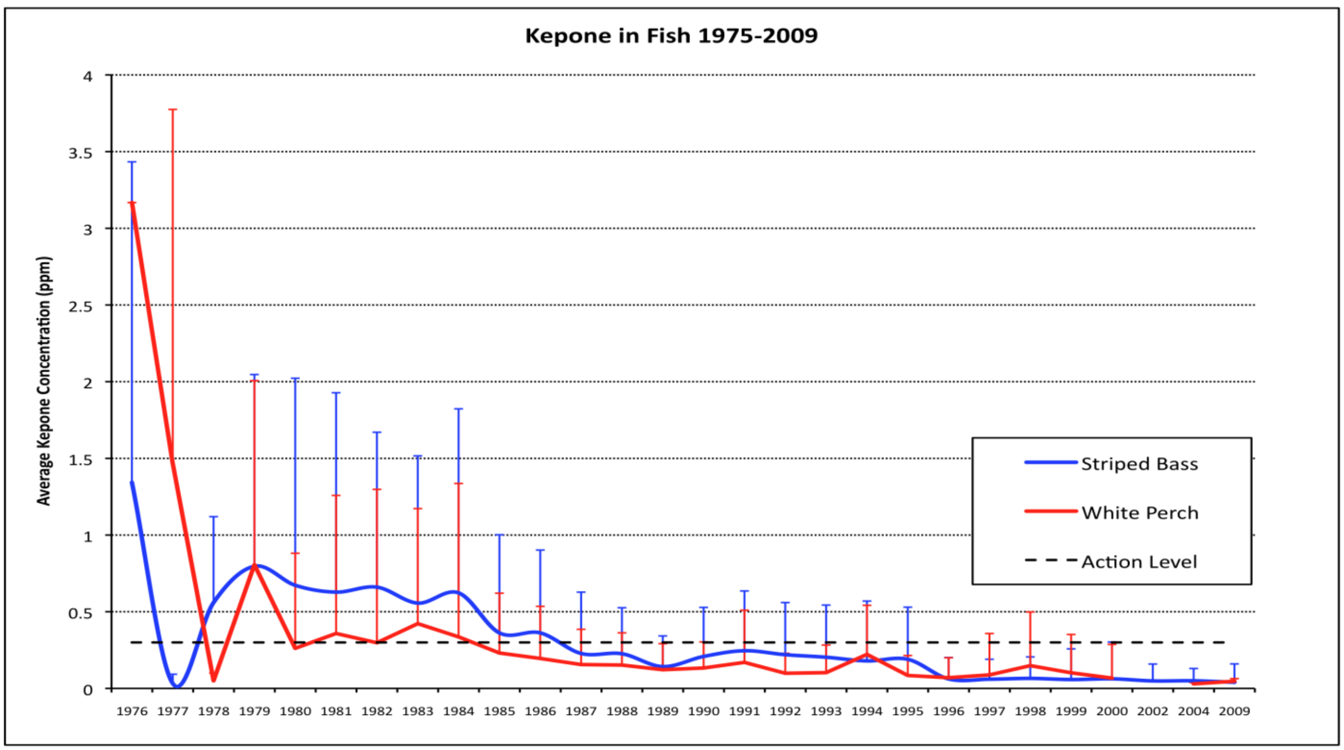

Figure 2. Trends in Kepone concentrations 1990-2009

Methods-*Sampling and Analyses*

Finfish samples were collected in collaboration with Virginia Department of Environmental Quality personnel to assure consistency with previous monitoring efforts. Samples were prepared and analyzed for Kepone at VIMS by personnel and methods used in previous monitoring efforts (Luellen et al., 2006). The fish were measured and weighed prior to dissection to remove a filet of edible tissue. In this method, a 10.0 g aliquot of homogenized edible fish tissue (filet) was chemically desiccated at a ratio 2:1 desiccant (9:1 sodium sulfate/precipitated silica (QUSO)) to tissue by weight. The desiccated samples were well mixed and frozen. The samples were soxhlet extracted with 350 milliliters of a mixture of 50/50 petroleum ether (Burdick & Jackson GC Pesticide Residue Analysis) / ethyl ether (Burdick & Jackson ACS/HPLC Reagent Grade) for 16 hours. The raw extract volume was reduced to 25.0 mL by heating. A 2.0 mL aliquot of the extract was eluted over activated Florisil® topped with sodium sulfate (1.6 gm each) and the fraction containing Kepone collected. A known amount of the internal standard, o,p' DDE (Supelco) was added to each sample. The sample extracts were analyzed using a gas chromatograph (Varian 3400) equipped with an electron capture ^{63}Ni detector (GC-ECD) and a Varian 8100 autosampler interfaced with Hewlett Packard's HP ChemStation rev.A.06.03 software. The GC-ECD was calibrated using a seven-point calibration curve weekly and checked daily with three standards. A laboratory blank accompanied each set of 10 samples and Kepone spiked matrix samples were also analyzed to assure accuracy of the method. Laboratory precision and accuracy was verified prior to the sample analysis at 0.01, 0.1 and 1.0 $mgkg^{-1}$ with spikes in clean fish tissue. The method detection limit was 0.01$mgkg^{-1}$ and variance for replicate samples was consistently less 3%. This method has remained essentially unchanged over the past 28 years.

Results

Sample Information and Quality Assurance/Control Analyses

Thirty-eight (38) striped bass and 47 white perch were collected and analyzed to evaluate the current (2016) Kepone concentrations in James River fish fillets. Striped bass were collected by VMRC as part of another monitoring program and provided to VADEQ personnel for this study. White perch were collected by VADEQ personnel at locations and by methods used in previous Kepone monitoring efforts. Striped bass were collected from Zones C, D and K in March-June 2016 and white perch were collected from zones C and D in May and June 2016 (zones shown in Figure 1.). Details of collection dates, locations and fish lengths and weights are presented in Appendix A.

To evaluate Kepone recovery from fish tissues, cod fillets were purchased from the local market. Cod was selected to assure that tissue samples were from a species not found locally that might contain any residual Kepone. Fillets were spiked with Kepone at concentrations ranging from 0.01-1.0 $mgkg^{-1}$ wet weight. Additional fillets were spiked at 0.1 $mgkg^{-1}$ and analyzed with each batch of field-collected samples to document recovery. Kepone recoveries ranged from 91-109% and averaged 100% ± 0.04% showing consistent excellent recovery throughout the study. No Kepone was detected above the detection limit (0.01 $mgkg^{-1}$) in any laboratory blanks extracted with each batch of samples. Details of these QA/QC results are provided in Appendix B.

Kepone concentrations in striped bass and white perch 2016

For the 38 striped bass and 47 white perch analyzed during this study, 11 and 19 samples, respectively, were below the detection limit (0.01 $mgkg^{-1}$ wet weight, Appendix C). This corresponds to approximately 65% of the fish analyzed still have reportable quantified concentrations of Kepone in their tissues more than 40 years after the event was first discovered. For the purpose of trend analyses, samples with concentrations below the detection limit (0.01 $mgkg^{-1}$) were set to ½ this value or 0.005 $mgkg^{-1}$.

Kepone concentrations for striped bass samples from the four Zones were similar and ranged from approximately 0.02 $mgkg^{-1}$ to 0.03 $mgkg^{-1}$ as shown in Figure 3. For the purposes of long-term trend analyses these data were combined due to the small sample sizes available for striped bass in 2016 and the similarity in concentrations across the zones in 2016. White perch average concentrations were also similar across the two Zones sampled but ranged from 0.015-0.02 $mgkg^{-1}$ for the two areas (Figure 4). A comparison of Kepone tissue concentrations with fish size (weight) showed that there was no obvious strong relationship for either species (Figures 5 and 6).

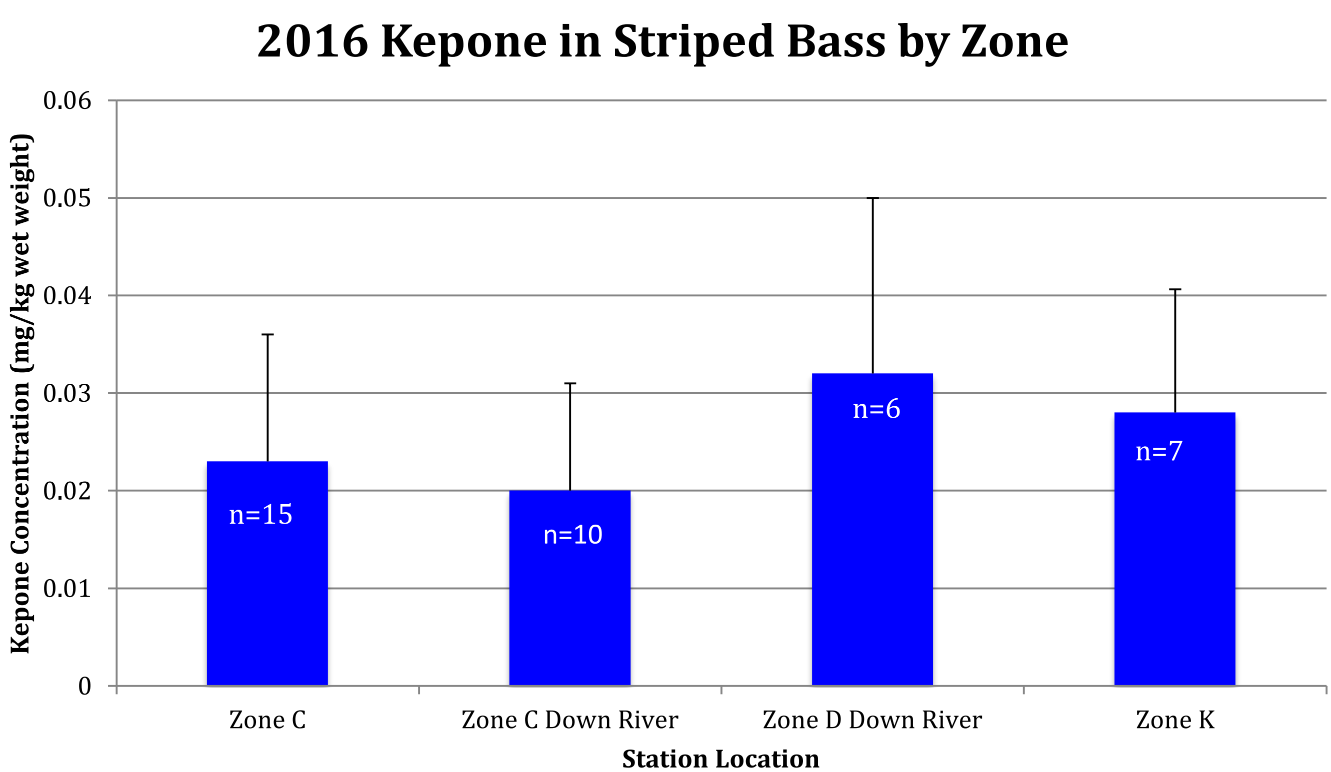

Figure 3. Kepone concentrations in striped bass 2016

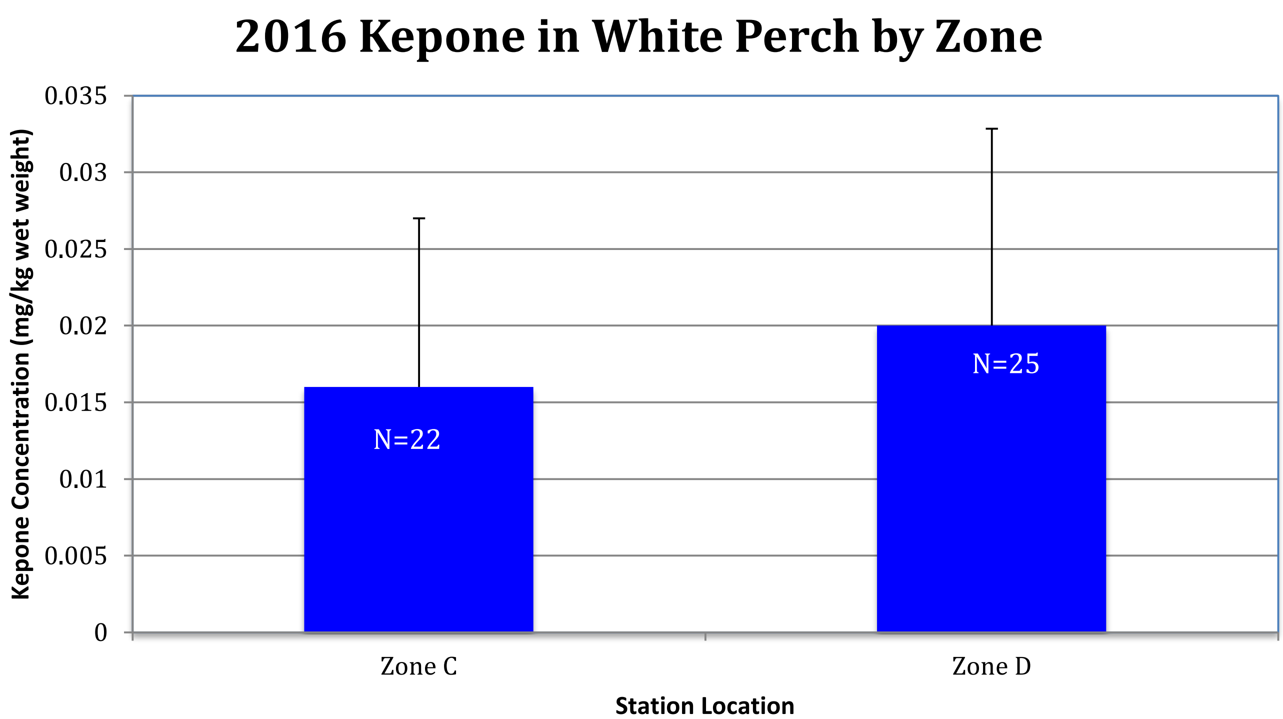

Figure 4. Kepone concentrations in white perch 2016

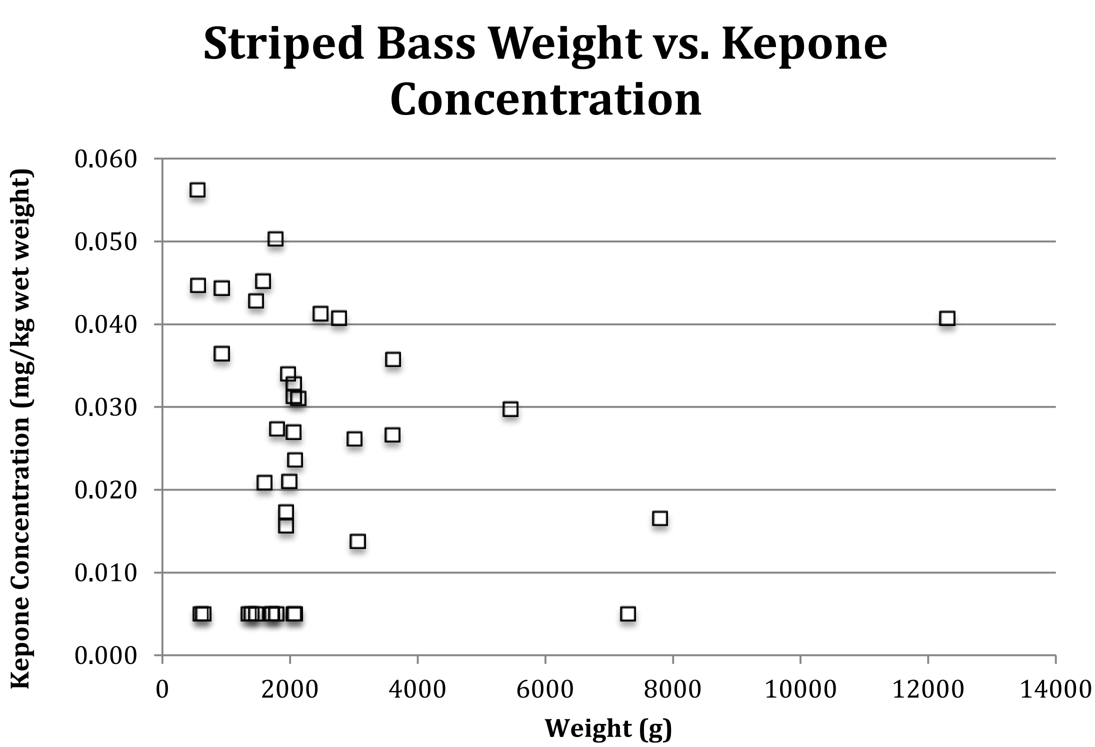

Figure 5. Striped bass weight vs. Kepone relationship

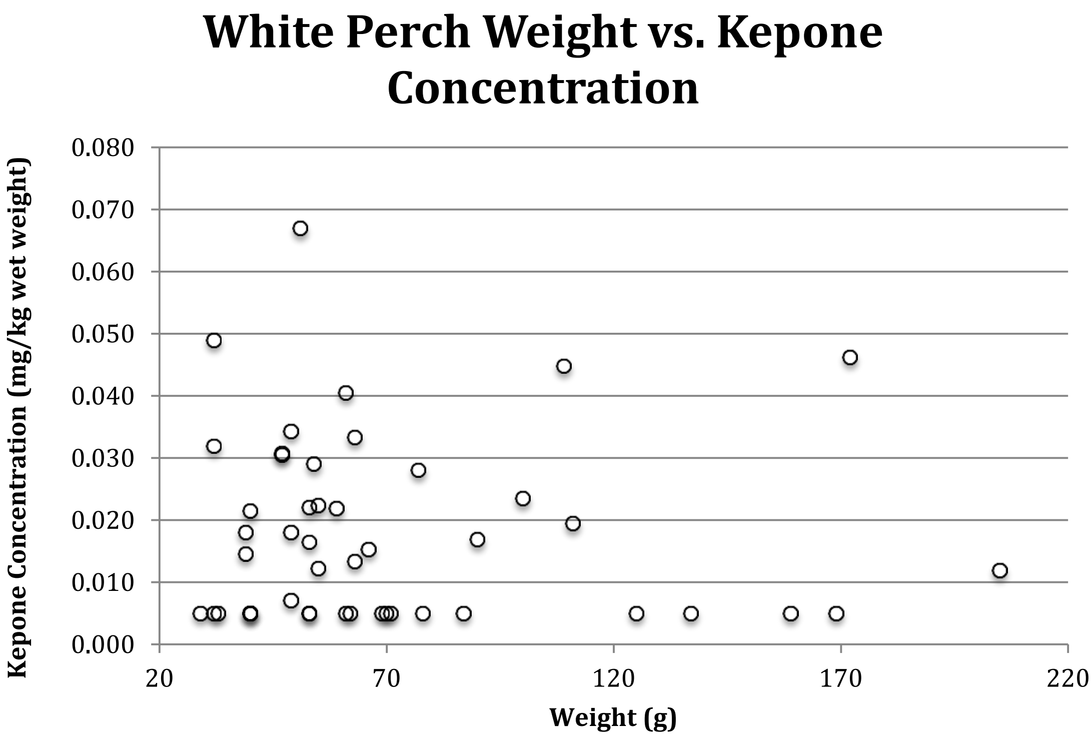

Figure 6. White perch weight vs. Kepone relationship

Long-term trends in Kepone for striped bass and white perch

A comparison of 2016 data (red points) with previous monitoring efforts shows that Kepone concentrations in striped bass and white perch are continuing to decline in Zone C (Figures 7-8). Based on the good fit ($R^2 > 0.85$) of exponential relationships describing the decrease in Kepone concentrations for both species, it is likely that average Kepone levels will be below the detection limit (0.01 $mgkg^{-1}$) by 2020-2025. This assumes that the decreasing trend will continue at the same exponential rate in the next 5-8 years. Another sampling effort should be considered within that time frame to verify if the decreasing trend continues as predicted by the models.

Previous research has shown that dredging activity in the James River might influence the Kepone bioavailability locally (Lundsford et al, 1987) so additional new sampling might be warranted more frequently or near the dredging, if that occurs. It is unlikely that limited dredging would have a prolonged or widespread effect of increasing fish tissue concentrations throughout the river like decades ago. The high levels found in the late 1970s and early 1980s were due to elevated surface sediment concentrations across much of the James River and resulted in a contaminated food chain with Kepone concentrations in fish closely related to surface sediment concentrations (Luellen et al, 2006). Kepone in sediments is also not evenly distributed (Nichols,

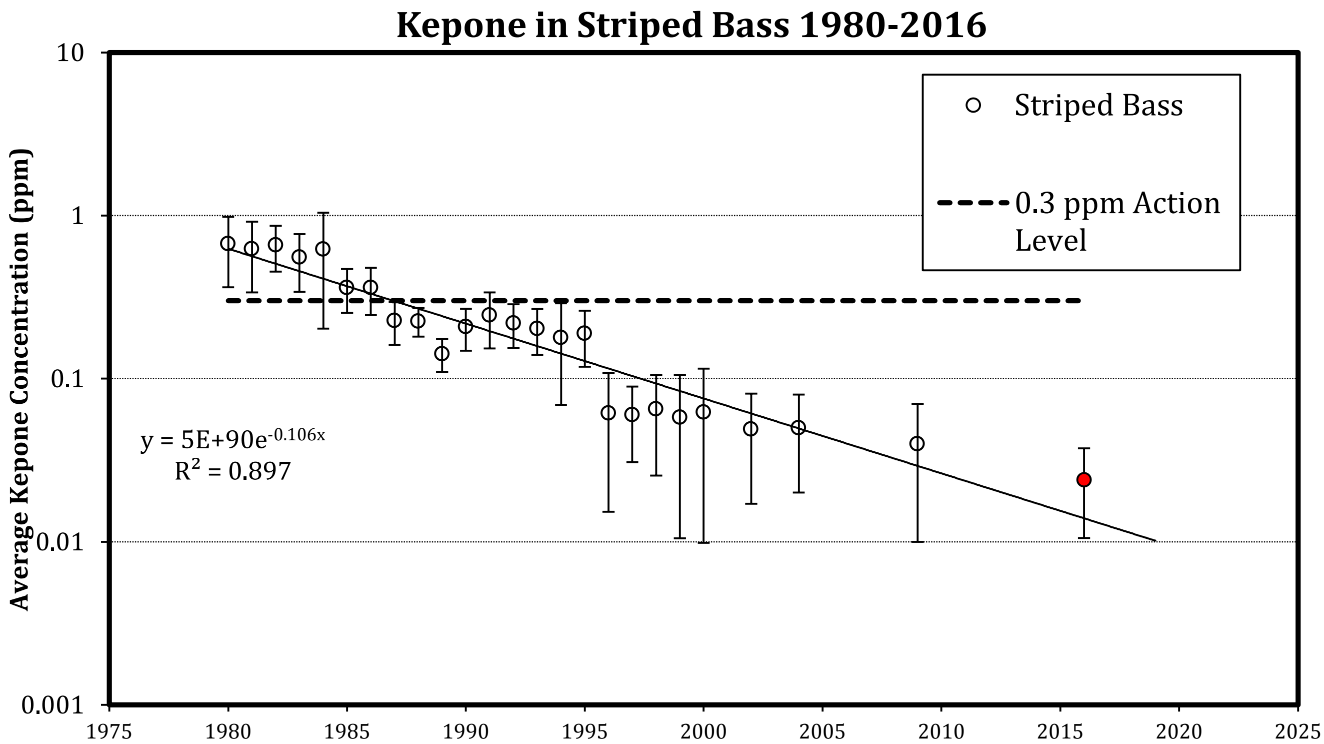

Figure 7. Kepone trends in striped bass 1980-2016

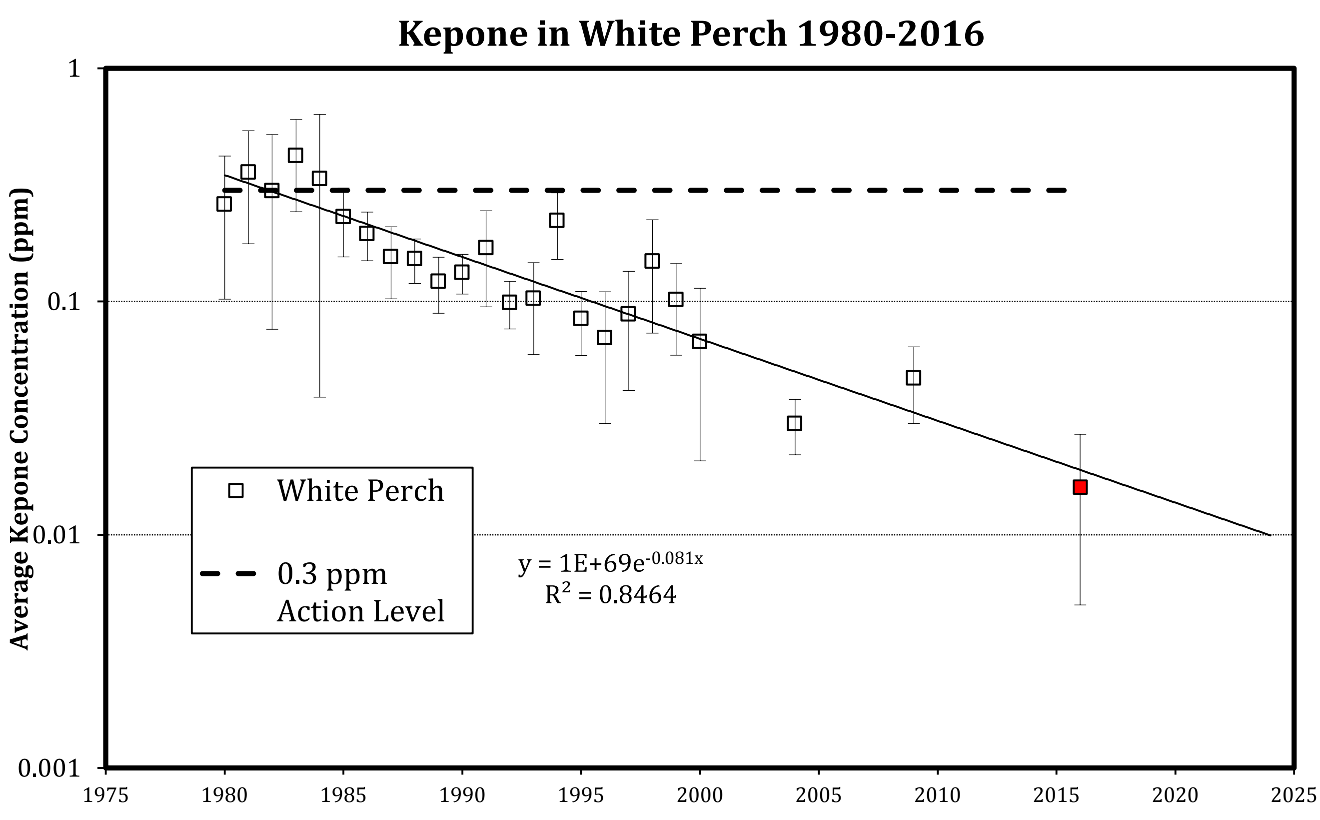

Figure 8. Kepone trends in white perch 1980-2016

1990) so dredging may or may not expose high Kepone concentrations locally and it will be dependant on the location and depth of the dredging. These events should be evaluated closely on a case-by-case basis.

Discussion

There has been some concern that a hurricane might disturb sediments in the James River and cause a recontamination of the food chain and once again bring increased risk from Kepone to fish consumers. Hurricane events are typically accompanied by large amounts of rainfall, flooding and increased runoff and suspended sediment into receiving waters. This increased sediment load should have the opposite effect and not expose old Kepone deposits. The deposition of clean surface sediments would likely decrease Kepone bioavailability even further. As part of a 2003 study funded by the VADEQ, VIMS analyzed oysters collected from the James River in October 2003, just weeks after Hurricane Isabel came through the region. Ten composite samples were analyzed from Deep Water Shoals and adjacent oyster reefs and all samples were below the 0.01 $mgkg^{-1}$ detection limit giving further support for the unlikely increase in Kepone in biota after a storm event. Sample identifications and results from that study are presented in Appendix D.

Some individuals have questioned if another Kepone like event could occur in Virginia's future. The answer is an unequivocal "yes". In the mid-1970's monitoring programs were limited and Kepone entered the James River without notice or identification until the adverse human health consequences were discovered at the Life Science Products facility in Hopewell. Fear of another Kepone type of event occurring led to the development of a Toxics Monitoring Program in Virginia that was funded by VADEQ. The Program used innovative analytical chemistry techniques developed at VIMS to survey samples around the Commonwealth for known toxic chemicals and to also look for unknown contaminants that may be of concern. This program discovered contaminants such as polychlorinated terphenyls (PCTs), polybrominated diphenyl ethers (PBDEs), nonylphenol surfactants, as well as previously unknown "hotspots" of PCBs and pesticides in sediments and tissues in Virginia. In subsequent years funding for such programs has diminished and monitoring instead has become focused on specific contaminants associated with known regulatory concerns. As a result the search for unidentified, new and emerging pollutants has been diminished. Emerging pollutants identified elsewhere in US waters, and likely also issues in the Commonwealth, include perfluorinated chemicals and pharmaceuticals. The adoption of the Virginia Environmental Laboratory Accreditation Program (VELAP) has increased the costs for environmental analysis as the certification program requires extensive documentation of QA/QC procedures and must be renewed every two years. The cost for VELAP certification and associated QA/QC requirements for Kepone analysis can easily exceed the actual cost for analyzing the monitoring samples. VELAP requires the use of standardized methods for a narrowly defined list of targeted analytes, as well as chemical-specific QC criteria. It is incompatible with the identification of untargeted pollutants. Adding to the problem has been the evolution of more sensitive analytical methods, as this improvement has been achieved by limiting the range of compounds detectable. Thus, untargeted contaminants will go unnoticed. We now are very good at quantifying what we look for, but only find what is on a list. The issue of new emerging contaminant issues is growing as the number of new drugs, domestic and industrial chemicals entering our waters continue to increase (Bernhardt et al, 2017).

Acknowledgements, Collaborations and Dissemination of Results

This project was possible due to funding provided by VEE and the contribution of effort from VADEQ and VMRC personnel to help acquire fish samples from the James River. Their commitment for collaborating on this project assured suitable samples were obtained to allow a direct comparison to historical data. This collaboration was critical for the project's success and is further evidence in the widespread desire for current Kepone fish tissue monitoring data. We especially thank Gabriel Darkwah and Roger Everton for helping to coordinate the fish collections. Wick Harlan and Cory Routh of VADEQ helped with white perch sampling and Matt Mainor of VIMS helped with all aspects of the Kepone analysis.

Results from this VEE sponsored monitoring effort were shared with the public and agency personnel at the recent 28th annual Environment Virginia Symposium April 4-6, 2017 at VMI in Lexington, VA. It is hopeful that this monitoring effort will underscore the need for an increase in the Virginia Commonwealth budget to fund future long-term monitoring programs that are important to understanding the fate of anthropogenic chemicals and their potential risks to human health and the environment.

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Appendix A. Fish Samples Collected for Kepone Analysis in 2016

VIMS Processing & Analyses																				
9/21/16					**2016 Kepone Fish Tissue Sampling Sites**															
Scheduled date:	Colle	Lab/S	**Site #**	La	**Stream Name**	**River Mile**	**Latitude**	**Longitude**	Collection Date	ID_Num	ID_Alp	Species	Specim	Length (cm)	Weight (gram)	Length (in)	Weight (lb)	ID_Num	ID_Alp	Species
Collection date:	Colle Zone	Lab/S	DEQ s	La	Station name/Location:	DEQ rivermile:	Latitude: (deg dec_min)	Longitude: (deg dec_min)	Collection Date	ID_Num	ID_Alp	Species	Specim	Length (cm)	Weight (gram)	Length (in)	Weight (lb)	ID_Num	ID_Alp	Species
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F1	61.5	3066	24.21	6.75			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F2	50.5	1600	19.88	3.52			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F3	53.3	1993	20.98	4.38			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F4	51.6	1941	20.31	4.27			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F5	46.0	1470	18.11	3.23			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F6	46.1	1355	18.15	2.98			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F7	52.8	1973	20.79	4.34			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F8	53.5	1472	21.06	3.24			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F9	53.5	12302	21.06	27.06			Downriver of C
03/10/2016 10:00	?	MRC	13		James River near Hog Island B	2-JMS034.27	N37 12 38.4998	W76 41 05.7001	03/10/2016 10:00	52	STB	Striped Bass	F10	52.5	2079	20.67	4.57			Downriver of C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F1	50.6	1582	19.92	3.48			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F2	52.7	1787	20.75	3.93			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F3	55.7	2060	21.93	4.53			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F4	54.5	2134	21.46	4.69			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F5	50.5	1774	19.88	3.90			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F6	47.7	1400	18.78	3.08			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F7	52.3	2084	20.59	4.58			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F8	53.5	2055	21.06	4.52			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F9	57.7	2479	22.72	5.45			Zone C
03/10/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/10/2016 12:00	52	STB	Striped Bass	F10	47.6	1801	18.74	3.96			Zone C
03/14/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/14/2016 12:00	52	STB	Striped Bass	F1	55.2	2060	21.73	4.53			Zone C
03/14/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/14/2016 12:00	52	STB	Striped Bass	F2	52.5	2061	20.67	4.53			Zone C
03/14/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/14/2016 12:00	52	STB	Striped Bass	F3	52.0	1714	20.47	3.77			Zone C
03/14/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/14/2016 12:00	52	STB	Striped Bass	F4	53.6	1940	21.10	4.27			Zone C
03/14/2016 12:00	C	MRC	12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	03/14/2016 12:00	52	STB	Striped Bass	F5	51.9	1709	20.43	3.76			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F1	13.5	29	5.31	0.06			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F2	15.5	47	6.10	0.10			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F3	14.2	40	5.59	0.09			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F4	22.5	159	8.86	0.35			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F5	16.0	53	6.30	0.12			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F6	11.7	14	4.61	0.03			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F7	17.0	71	6.69	0.16			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F8	8.7	8	3.43	0.02			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F9	9.9	11	3.90	0.02			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F10	9.9	11	3.90	0.02			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F11	12.6	24	4.96	0.05			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F12	13.2	29	5.20	0.06			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F13	13.4	29	5.28	0.06			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F14	14.2	32	5.59	0.07			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F15	13.7	32	5.39	0.07			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F16	14.7	40	5.79	0.09			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F17	12.9	28	5.08	0.06			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F18	14.2	39	5.59	0.09			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F19	14.8	39	5.83	0.09			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F20	15.6	47	6.14	0.10			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F21	15.6	49	6.14	0.11			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F22	14.5	40	5.71	0.09			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F23	14.1	32	5.55	0.07			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F24	14.5	40	5.71	0.09			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F25	16.6	55	6.54	0.12			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F26	13.8	33	5.43	0.07			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F27	15.6	49	6.14	0.11			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F28	23.0	169	9.06	0.37			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F29	20.4	111	8.03	0.24			Zone C
05/24/2016 12:00	C		12		James River near mouth of Chi	2-JMS049.00	N37 13 05.5999	W76 53 42.0698	05/24/2016 12:00	60	WP	White Perch	F30	17.3	70	6.81	0.15			Zone C
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F1	17.0	69	6.69	0.15			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F2	16.6	59	6.54	0.13			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F3	18.7	77	7.36	0.17			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F4	20.5	125	8.07	0.28			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F5	21.9	137	8.62	0.30			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F6	23.3	205	9.17	0.45			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F7	19.3	100	7.60	0.22			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F8	19.5	109	7.68	0.24			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F9	22.5	172	8.86	0.38			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F10	18.1	90	7.13	0.20			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F11	18.5	87	7.28	0.19			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F12	17.2	78	6.77	0.17			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F13	16.5	61	6.50	0.13			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F14	16.5	61	6.50	0.13			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F15	16.6	62	6.54	0.14			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F16	16.0	52	6.30	0.11			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F17	16.9	63	6.65	0.14			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F18	15.5	54	6.10	0.12			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F19	15.7	53	6.18	0.12			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F20	15.2	53	5.98	0.12			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F21	15.0	49	5.91	0.11			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F22	15.1	53	5.94	0.12			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F23	15.7	53	6.18	0.12			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F24	15.0	49	5.91	0.11			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F25	15.8	63	6.22	0.14			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F26	15.9	66	6.26	0.15			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F27	14.9	44	5.87	0.10			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F28	15.2	51	5.98	0.11			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F29	14.7	44	5.79	0.10			Zone D
06/02/2016 12:00	D	2016	9		James River near Jordan Point	2-JMS074.44	37.3170500	-77.2236167	06/02/2016 12:00	60	WP	White Perch	F30	15.7	55	6.18	0.12			Zone D
06/09/2016 11:00	?	2016	10		James River near Windmill Poi	2-JMS066.88	37.3108333	-77.0931667	06/09/2016 11:00	52	STB	Striped Bass	F1	45.7	933	17.99	2.05			Downriver of D
06/09/2016 11:00	?	2016	10		James River near Windmill Poi	2-JMS066.88	37.3108333	-77.0931667	06/09/2016 11:00	52	STB	Striped Bass	F2	46.9	932	18.46	2.05			Downriver of D
06/09/2016 11:00	?	2016	10		James River near Windmill Poi	2-JMS066.88	37.3108333	-77.0931667	06/09/2016 11:00	52	STB	Striped Bass	F3	40.3	642	15.87	1.41			Downriver of D
06/09/2016 11:00	?	2016	10		James River near Windmill Poi	2-JMS066.88	37.3108333	-77.0931667	06/09/2016 11:00	52	STB	Striped Bass	F4	39.7	564	15.63	1.24			Downriver of D
06/09/2016 11:00	?	2016	10		James River near Windmill Poi	2-JMS066.88	37.3108333	-77.0931667	06/09/2016 11:00	52	STB	Striped Bass	F5	40.5	554	15.94	1.22			Downriver of D
06/09/2016 11:00	?	2016	10		James River near Windmill Poi	2-JMS066.88	37.3108333	-77.0931667	06/09/2016 11:00	52	STB	Striped Bass	F6	40.3	603	15.87	1.33			Downriver of D

Appendix B. Kepone QA/QC Results

Kepone Analyses QAQC Results
12/13/16

Laboratory Blanks:

ID	
Cod-Blk	nd
Blk 11162016	nd
Blk 11282016	nd
Blk 11292016	nd
Blk 12012016	nd
Blk 12052016	nd
Blk 12062016	nd
Blk 12072016	nd
Blk 12082016	nd
Blk 12122016	nd

Fortified Sample Recovery:

ID	Conc. (ppm)	Rec (%)	
Cod-1	0.01	108%	
Cod-2	0.1	99%	
Cod-3	0.1	93%	
Cod-4	0.1	98%	
Cod-5	1	99%	
F14781R	0.1	105%	
F14791R	0.1	101%	
F14801R	0.1	91%	
F14806R	0.1	109%	
F14822R	0.1	103%	
F14830R	0.1	96%	
F14833R	0.1	98%	
F14851R	0.1	100%	
			100%
			0.040227564

Daily GC_ECD Calibration Standard Check:
GC-ECD 7 point Calibration Curve was determined weekly.

Appendix C. Fish Tissue Kepone Results 2016

			2016 Kepone Fish Tissue Results					Kepone
Fish ID	Species	Collection Date/Time:	**Stream Name**	**River Mile**	Kepone Zone	Length	Weight	Conc (ppm)
						cm	gm	
F14772	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	61.5	3066	0.01
F14773	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	50.5	1600	0.02
F14774	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	53.3	1993	0.02
F14775	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	51.6	1941	0.02
F14776	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	46.0	1470	<0.01
F14777	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	46.1	1355	<0.01
F14778	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	52.8	1973	0.03
F14779	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	53.5	1472	0.04
F14780	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	53.5	12302	0.04
F14781	Striped Bass	03/10/2016 10:00	James River near Hog Island Buoy 42	2-JMS034.27	Downriver of C	52.5	2079	<0.01
F14782	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	50.6	1582	0.05
F14783	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	52.7	1787	<0.01
F14784	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	55.7	2060	<0.01
F14785	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	54.5	2134	0.03
F14786	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	50.5	1774	0.05
F14787	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	47.7	1400	<0.01
F14788	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	52.3	2084	0.02
F14789	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	53.5	2055	0.03
F14790	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	57.7	2479	0.04
F14791	Striped Bass	03/10/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	47.6	1801	0.03
F14792	Striped Bass	03/14/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	55.2	2060	0.03
F14793	Striped Bass	03/14/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	52.5	2061	0.03
F14794	Striped Bass	03/14/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	52.0	1714	<0.01
F14795	Striped Bass	03/14/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	53.6	1940	0.02
F14796	Striped Bass	03/14/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	51.9	1709	<0.01
F14797	Striped Bass	06/09/2016 11:00	James River near Windmill Point powerline	2-JMS066.88	Downriver of D	45.7	933	0.04
F14798	Striped Bass	06/09/2016 11:00	James River near Windmill Point powerline	2-JMS066.88	Downriver of D	46.9	932	0.04
F14799	Striped Bass	06/09/2016 11:00	James River near Windmill Point powerline	2-JMS066.88	Downriver of D	40.3	642	<0.01
F14800	Striped Bass	06/09/2016 11:00	James River near Windmill Point powerline	2-JMS066.88	Downriver of D	39.7	564	0.04
F14801	Striped Bass	06/09/2016 11:00	James River near Windmill Point powerline	2-JMS066.88	Downriver of D	40.5	554	0.06
F14802	Striped Bass	06/09/2016 11:00	James River near Windmill Point powerline	2-JMS066.88	Downriver of D	40.3	603	<0.01
F14803	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	13.5	29	<0.01
F14804	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	15.5	47	0.03
F14805	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.2	40	<0.01
F14806	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	22.5	159	<0.01
F14807	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	16.0	53	<0.01
F14808	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	17.0	71	<0.01
F14809	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.2	32	<0.01
F14810	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	13.7	32	0.05
F14811	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.7	40	<0.01
F14812	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.2	39	0.02
F14813	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.8	39	0.01
F14814	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	15.6	47	0.03
F14815	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	15.6	49	0.03
F14816	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.5	40	<0.01
F14817	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.1	32	0.03
F14818	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	14.5	40	0.02
F14819	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	16.6	55	0.02
F14820	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	13.8	33	<0.01
F14821	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	15.6	49	0.02
F14822	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	23.0	169	<0.01
F14823	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	20.4	111	0.02
F14824	White Perch	05/24/2016 12:00	James River near mouth of Chickahominy River	2-JMS049.00	Zone C	17.3	70	<0.01
F14825	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	17.0	69	<0.01
F14826	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	16.6	59	0.02
F14827	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	18.7	77	0.03
F14828	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	20.5	125	<0.01
F14829	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	21.9	137	<0.01
F14830	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	23.3	205	0.01
F14831	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	19.3	100	0.02
F14832	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	19.5	109	0.04
F14833	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	22.5	172	0.05
F14834	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	18.1	90	0.02
F14835	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	18.5	87	<0.01
F14836	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	17.2	78	<0.01
F14837	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	16.5	61	<0.01
F14838	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	16.5	61	0.04
F14839	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	16.6	62	<0.01
F14840	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	16.9	63	0.01
F14841	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.5	54	0.03
F14842	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.7	53	0.02
F14843	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.1	53	0.02
F14844	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.7	53	<0.01
F14845	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.0	49	0.01
F14846	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.8	63	0.03
F14847	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.9	66	0.02
F14848	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.2	51	0.07
F14849	White Perch	06/02/2016 12:00	James River near Jordan Point at Rt. 156	2-JMS074.44	Zone D	15.7	55	0.01
F14850	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	89.5	7800	0.02
F14851	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	86.2	7300	<0.01
F14852	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	72.4	5459	0.03
F14853	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	66.0	3616	0.04
F14854	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	63.6	3607	0.03
F14855	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	63.6	3016	0.03
F14856	Striped Bass	04/28/2016 10:30	James River near I-95	2-JMS110.00	Zone K	59.2	2768	0.04

Appendix D. Oyster Samples collected and Analyzed after Hurricane Isabel, 2003.

Kepone Results from James River Oysters

30-Oct-03

Each sample was a composite of 5 oysters (shucked & homogenized).
A 10.0 gm aliquot from each composite was desiccated & frozen overnight
Extraction and analysis followed standard kepone protocol.
No sample chromatograms contained an indication of a peak representing kepone
Quantitation Limit = 0.01 ppm

Sample Id	Date Analyzed	Kepone Wet Wgt Concentration (ppm)	Date Collected	Sample Depth (m)	Latitude Deg_min	Longitude Deg_min
St 7 Dry Shoal A	10/30/03	<0.01	10/24/03	4.3	37_03.683	76_36.233
St 7 Dry Shoal B	10/30/03	<0.01	10/24/03	4.3	37_03.683	76_36.233
St 6 Long Shoal A	10/30/03	<0.01	10/24/03	3.0	37_04.583	76_37.017
St 6 Long Shoal B	10/30/03	<0.01	10/24/03	3.0	37_04.583	76_37.017
St 1 Deep Water Shoal A	10/30/03	<0.01	10/24/03	3.7	37_08.933	76_38.133
St 1 Deep Water Shoal B	10/30/03	<0.01	10/24/03	3.7	37_08.933	76_38.133
St 3 Horsehead A	10/30/03	<0.01	10/24/03	3.0	37_06.400	76_38.033
St 3 Horsehead B	10/30/03	<0.01	10/24/03	3.0	37_06.400	76_38.033
St 4 Point of Shoal A	10/30/03	<0.01	10/24/03	3.0	37_04.617	76_38.600
St 4 Point of Shoal B	10/30/03	<0.01	10/24/03	3.0	37_04.617	76_38.600

QAQC Id	Date Analyzed	Exp. Kepone Conc (ppm)	Calc. Kepone Conc (ppm)	Recovery (%) Kepone
Recalibate method	10/29/03			
Pseudo@0.1ppm	10/29/03	0.08802	0.0973	110
Lab Blk 01/24/02	10/30/03	nd	-	-
Pseudo@0.1ppm	10/30/03	0.08802	0.0904	103
St 4 Point of Shoal B rep	10/30/03	0.119	0.121	101