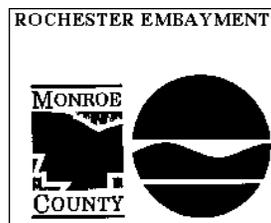


**Rochester Embayment, New York
Remedial Action Plan
Beneficial Use Impairment (BUI) Indicator Removal (Delisting)
for the BUI: Fish Tumors and Other Deformities.**



July 2014

County of Monroe, Monroe County Department of Health
(Local RAP Coordination)

Rochester Embayment Remedial Action Plan Oversight Committee
(Technical and Advisory Committee Members)

New York State Department of Conservation
(Great Lakes Areas of Concern Coordination and Oversight)

This Beneficial Use Indicator (BUI) indicator removal report was compiled by Monroe County and New York State Department of Environmental Conservation (NYSDEC) based on historical record and long-term efforts of the Remedial Action Plan (RAP) Remedial Advisory Committee in collaboration with the current Rochester Embayment Oversight Committee for the RAP. Long-term and ongoing RAP Coordination funding and consultation has been provided by the United States Environmental Protection Agency, Region 2. The removal of this BUI indicator has involved government agencies, professionals, peers, and the public in review. All substantive comments have been incorporated into this final publication. For information or copies please contact the lead RAP Coordinator in Monroe County Department of Health or NYSDEC Division of Water per the committee contact information in Appendix A.

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I. Executive Summary

This report summarizes the documentation from the Rochester Area of Concern related to Fish Tumors or Other Deformities BUI and the Rochester Embayment Remedial Action Committee (RERAC) recommends the removal of the BUI in the Rochester Embayment Area of Concern (AOC) per the process outlined in the Guidance for Delisting New York's Great Lakes Areas of Concern (NYSDEC 2010).

This report presents analyses of fish (brown bullhead) tissue data and chemical contaminant data collected in the Rochester Embayment AOC. It includes the observations and recommendations from NYSDEC fisheries management. Additionally it summarizes the remedial actions and source control activities of New York's remedial cleanup programs at sites within the REAOC, contributing to the removal of this BUI.

The criteria for removal of the Fish Tumors and Other Deformities BUI in the Rochester Embayment AOC were adapted directly from the International Joint Commission guidelines, which state:

1. Incidence rates of fish tumors or other deformities do not exceed rates at non-AOC control sites; and
2. Survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullhead or suckers.

The first and second criteria are satisfied based on the Haynes and Neuderfer study (2011) which found that results of fish liver tumor prevalence in the Rochester AOC did not exceed the non AOC reference site Oak Orchard Creek. The results showed a total of nine preneoplastic liver lesions were found in nine fish from each the AOC and the reference site and only one neoplastic liver tumor was found in a fish from the reference site. This report relies on the evidence herein that demonstrates, no neoplastic tumors were identified in brown bullhead from the REAOC. Due to uncertainties surrounding which lesions are preneoplastic or the progression of preneoplastic lesions to neoplastic lesions ~~it is recommended~~ the RAC and technical sub-committee consider that preneoplastic lesions should not be used as a reliable impairment criterion. Therefore, the first and second criteria are met.

The second criterion is also satisfied due to the fact that the embayment and Genesee River are extensively fished by both amateur and professional anglers and no public accounts of tumors in fish caught in the Rochester Embayment were reported to NYSDEC or Monroe County Department of Health (MCDOH) for several years. Although the reason for no reports is unclear, it may be due to low numbers of tumors or anglers are used to seeing tumors and no longer call. Because of bias and uncertainty of an angler survey associated with this BUI criteria, the RAC has decided that survey data collected from the general public cannot be depended on to accurately identify these types of liver lesions. If Survey is taken as synonymous with sampling and examination for neoplastic and preneoplastic lesions, then the previously mentioned study indicates that no neoplastic lesions were found in AOC fish.

Accordingly it is recommended that the classification of the Fish Tumors or Other Deformities Beneficial Use be changed from *Impaired* to *Not Impaired*.

II. Background

The Rochester Embayment is a broad triangular bay on the south shore of Lake Ontario at the mouth of the Genesee River. It stretches from Bogus Point to Nine Mile Point and is delineated by a straight line between these two points. This area is approximately 35 square miles and includes Braddock Bay and

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approximately 6 miles of the lower Genesee River, from the mouth of the river to the Lower Falls (Figure 1). This area has been designated as one of 43 Areas of Concern in the Great Lakes Basin.



Figure 1- Rochester Embayment Area of Concern

When the Stage I (MCDPD 1993) and Stage II (MCDOH 1997) RAPs were drafted, not enough information was available to determine if this BUI was in fact impaired in the AOC. Although evidence existed that suggested the BUI could be impaired.

Historically Rochester Gas and Electric Corporation (RG&E) operated several Manufactured Gas Plants in the area that produced a coal tar byproduct, these coal tars were identified as sources of polycyclic aromatic hydrocarbons (PAHs). Studies conducted on fish tumors suggested causes related to anthropogenic contaminants such as PAHs. Studies of brown bullheads from Lake Erie tributaries showed a strong link between PAH contaminated sediment and fish tumors (Harshbarger et al, 1984, Smith et al, 1994, Baumann & Harshbarger 1995, Pinkney et al. 2009). However studies conducted in New York State found high incidences of liver tumors in brown bullhead from relatively unpolluted lakes suggesting that factors other than contaminants may also cause fish tumors (Bowser et al, 1991, Poulet et al, 1994, Spitsbergen & Wolfe 1995). Other studies conducted in Chesapeake Bay and Lake Erie tributaries found inconsistent relationships between PAH sediment contamination and brown bull head liver tumor incidences (Baumann 2010, PADEP 2012, Pickney et al, 2011). Recent experiments exposing brown bullhead to PAH contaminated sediment did not induce liver tumors (PADEP 2012).

Available data at the writing of the Stage II RAP included RG&E's reporting tumor incidence in their annual fish impingement reports to NYS and The State University of New York (SUNY) Brockport analyzed tumor incidence as part of their fisheries management curriculum coursework. Fish observed from both of these sources did not demonstrate a high incidence of tumors and were considered isolated

incidents and examined fish only for visible deformities. Neither entity examined fish for specific liver tumors relative to the BUI delisting criteria.

Given these apparent contradictions in the scientific literature and little data there was insufficient evidence to justify listing the beneficial use as impaired. Although, additional lines of evidence indicate conditions and characteristics unique to the AOC necessitating the need to evaluate ecological impacts of certain types of environmental contaminants, hence the BUI was listed as unknown with further assessment required.

A. Delisting Criteria

In accordance with the MCDOH Stage I and Stage II Remedial Action Plans and the International Joint Commission (IJC) Delisting Guideline for Fish Tumors and Other Deformities, the Tumor and Other Deformities BUI can be delisted when the following criteria have been met:

1. Incidence rates of fish tumors or other deformities do not exceed rates at non-AOC control sites; and
2. Survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullhead or suckers.

B. Endpoint

The desired endpoint for the Fish Tumor and Other Deformities BUI is to demonstrate that the incidence rates of neoplastic tumors occurring in the Rochester Embayment AOC are no greater than incidence rates at non-AOC control sites and that the livers of bullheads or suckers from the AOC are neoplastic tumor free.

C. BUI Removal Comments and Report Preparation

A Technical Review Team was assembled to evaluate the status change in designation of this BUI. The evaluation included conducting a thorough review of technical reports and supporting documents.

Through the evaluation, the Technical Review Team addressed the following questions:

1. Are the methods and results cited in the report or presentation materials technically and scientifically sound?
2. Does the information cited in the report regarding restoration of the impaired beneficial use support the delisting criteria?
3. Concur that the delisting criteria have been met?

Team members prepared a technical report with their conclusions including whether the evidence and scientific rationales put forward in the report support the position that the delisting criteria have or have not been met for the beneficial use.

III. Indicator Status Resolution

A. Strategy and rationale

The United State Environmental Protection Agency (USEPA) Delisting Guidance document: *Restoring United States Great Lakes Areas of Concern: Delisting Principles and Guidelines*, adopted by the United States Policy Committee (USPC 2001) states the following:

“Re-designation of a BUI from impaired to unimpaired can occur if it can be demonstrated that:

- Approved delisting criteria for that BUI have been met;
- The impairment is not solely of local geographic extent, but is typical of upstream conditions OR conditions outside of the AOC boundaries on a regional scale. Such re-designation would be contingent upon evidence that sources within the AOC are controlled;
- The impairment is due to natural rather than human causes. “

The IJC delisting guidelines from 1991 state that this Beneficial Use may be deemed to be Not Impaired “when the incidence rates of fish tumors or other deformities do not exceed rates at unimpacted control sites or when survey data confirm the absence of neoplastic or preneoplastic liver lesions in bullheads or suckers” (IJC, 1991).

Brown bullhead have been selected by the IJC as an indicator species because their bottom-feeding and sediment-burrowing habits expose them to contaminants in sediment via direct contact and absorption through skin and gills, and also through ingestion of benthic organisms and sediment detritus. Brown bullheads are a good indicator because they are tolerant of contaminants, they are a common species in the nearshore area, have a limited home range and they are a species that is consumed by humans. Due to the limited home range of brown bullhead it is more likely these fish are resident in the nearshore areas of the embayment portion of the AOC and that the brown bullhead captured in Braddock Bay are a good representation of the whole AOC. It is possible that White Sucker was included due to similar habits and habitats, albeit with less tolerance for low oxygen conditions, or as a surrogate for Bullheads in environments of the Great Lakes where they are not common, such as streams with stony bottoms and faster flow.

The report herein contains the necessary information to state the case that the Fish Tumors and Other Deformities Beneficial Use Impairment indicator for the Rochester Embayment AOC has met the above conditions for the Remedial Action Plan process to the maximum extent practicable based on the current data. Further, based upon the evidence presented in this document the Fish Tumor and Other Deformities BUI current status of impaired should be redesignated as not impaired.

B. Supporting Data and Assessment.

The basis of determining the status of the BUI follow the methodologies and guidance developed to improve the consistency of assessing, documenting, and monitoring the Fish Tumors or Other Deformities BUI in Great Lakes AOCs (Rafferty, S. and J. Grazio. 2006, Blazer et al.2007). Additional guidance is used to narrow the focus of studies used to determine BUI status in the following bulleted list Baumann (2010).

- External lesions including lip papillomas are not a good criterion for carcinogen exposure. These lesions can be caused by non-contaminant sources such as viruses. Occurrence of external lesions does not correlate well with occurrence of liver tumors.
- Preneoplastic lesions are not a good criterion for carcinogen exposure. Specifications as to what constitutes a preneoplasm have not been provided. Also, the extent to which preneoplasms develop into neoplasms or cancer is unknown.
- Liver neoplasms are the most consistent marker of carcinogen exposure. Research has established links between chemical contaminants and liver lesions in wild fish, and PAHs and liver cancer in fish. Viruses have not been found to cause liver cancer in fish.

- The 1991 IJC guidelines state that locations determined to be impaired might be designated as restored when “tumors...do not exceed rates at unimpacted control sites”. Research has found that even in urban areas (without a major point source), a reasonable rate of liver neoplasm prevalence would be 2 percent or less.
- Age and gender are two variables which might influence tumor prevalence. Age is recognized as positively correlated with tumor prevalence. Gender is less consistent with respect to some types of tumors but should be considered for comparative purposes.

Further, the recommendation to use only neoplastic lesions is considered when calculating tumor incidence due to the uncertainties of which lesions are preneoplastic and progress to tumors (Blazer et.al, 2009)

A study was conducted by SUNY Brockport in 2010 to determine the status of the Fish Tumor and Other Deformities BUI for the Rochester Embayment AOC (REAOC). This study compared the prevalence of internal and external tumors and deformities found in brown bullhead from the AOC to a reference area, Oak Orchard Creek (OOC) (Haynes and Neuderfer 2011). Oak Orchard Creek was recommended by NYSDEC as a suitable control creek for the comparison of fish and wildlife survey results. Oak Orchard similarities to Genesee River included, both creeks are tributaries of Lake Ontario, similar surrounding geography, and are subject to water level fluctuations due to changes in lake water levels, and contain hydro-electric dams some distance from the confluences of the creeks with the lake (E&E 2009). Brown bullheads were successfully collected from within Braddock Bay of the REAOC and the OOC reference site.

The Rochester Embayment AOC includes the Genesee River and embayment. It was intended that the tumor study by Haynes and Neuderfer (2011) should include an equal number of brown bullheads caught in both locations, to fully represent the AOC. Brown bullhead were chosen as a sentinel indicator of the AOC due to their limited home range which is assumed to be the nearshore areas of the embayment portion of the REAOC. However, the researchers did not find any brown bullhead in the lower Genesee River the Fall of 2010 when the fish sampling took place, although many other species of fish were captured. The researchers speculated that brown bullhead were not found due to the potential lack of necessary habitat conducive for maintaining a resident brown bullhead population. Brown bullhead are bottom dwelling catfish inhabiting slow moving water with a sand or mud bottom and abundant aquatic vegetation (Rafferty et al 2009). The only places with emergent embedded macrophytes (cattail beds) and submergent (mud flats) vegetation in the lower river are likely too shallow (<1 ft of water in most places) to sustain brown bullhead which are light-sensitive, nocturnal animals (Haynes 2012 pers. comm.). Two brown bullhead were caught by Haynes in the fall of 2011 using gill nets (Haynes 2012 pers. comm.). Additional anecdotal evidence substantiating the lack of Genesee River fish was a U.S. Fish and Wildlife Service (USFWS) sampling the lower Genesee River in the fall 2010, a few days after the sampling by Haynes. The USFWS service reported fewer than 20 brown bullhead were caught in fyke nets although many other species of fish were successfully caught (USFWS 2010). USFWS researchers attributed low catch counts of brown bullhead to collection method and time of year as factors. The following year the USFWS sampled in the spring of 2011 using modified fyke nets and caught 42 brown bullhead during three days of sampling (USFWS 2011). No report of the findings of this study were available at this time.

Both USFWS and Haynes speculate that brown bullhead are more likely present in the river during the spawning season (late spring) than other times of the year. USFWS also states bullhead would also be present foraging in the river foraging until water temperature drops to 18 degrees Celsius (USFWS 2010). Haynes also speculates brown bullhead captured in the spring are adults from Lake Ontario which return to the lake after spawning in the lower Genesee River (2012 pers. comm.). NYS DEC

Fisheries Unit has briefly characterized the habitat in the lower Genesee River portion of the Rochester AOC which identifies limited brown bull head habitat (DEC 2012). Given the apparent lack of suitable habitat for brown bullhead in the lower Genesee River it is not surprising that brown bullhead were not captured in large numbers in the fall and that they likely migrate to the lake as juveniles and return when they have reached adult status. A total of one hundred fish were ultimately used for the REAOC study; fifty were targeted from the reference site, Oak Orchard Creek and fifty from Braddock Bay upon approval from USEPA the Quality Assurance Project Plan (QAPP) was changed to allow for additional fish to be caught from Braddock Bay as a substitute for the lack of river fish.

A number of morphological measurements and visual observations were taken for each fish sampled following the field sampling procedures in Rafferty and Grazio (2006). The embayment portion of the AOC and reference sites had a total of 100 adult bullhead taken with an average total length >300 mm although a distributed length range was collected from 270 to 390 mm (REAOC 2010 and OOC 2010 data series) Figure 2. Otoliths and pectoral fin spines were removed from each fish and used to determine age and adult status. The average ages of brown bullhead were 9.5+/-0.6 and 8.3+/-0.4 years in the REAOC and OOC reference area respectively. It should be noted that we might expect that if more tumors were found in REAOC it might be due or partially due to older age. External tissues judged to be abnormal in the field were collected and submitted for microscopic evaluation. Biopsied skin and mouth lesions resulted in a positive result for skin tumors if papillomas, squamous cell carcinomas, or melanomas were detected (Table 1). None of these external lesions were interpreted as malignant neoplasms. These external tumors were not considered for determining status of the BUI, due to the lack of experimental evidence implicating chemical contaminant exposure (Baumann and Dabrowski 2006) and are an unreliable indicator of environmental degradation based on inconsistencies or the ability to isolate causal factors resulting in the formation of external tumors (PADEP 2012).

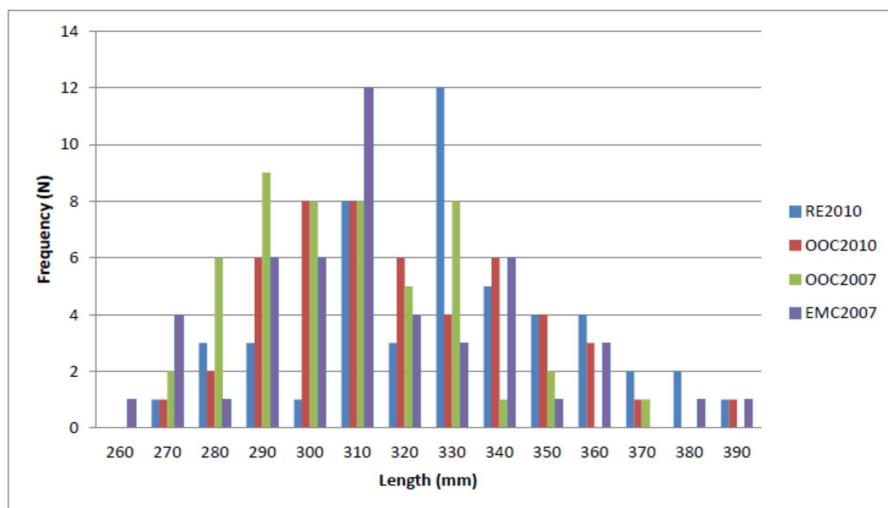


Figure 2. Length frequencies of brown bullhead in the Rochester Embayment AOC (2010), Oak Orchard Creek reference area (2007 and 2010) and Eighteenmile Creek AOC (2007) (Haynes and Neuderfer 2011).

Histo-pathological procedures on liver tissue were performed according to Blazer et al. (2007). A fish was considered to have a neoplastic liver tumor if histopathology showed the presence of hepatocellular adenomas, hepatocellular carcinomas, cholangiomas, or cholangiocarcinomas. A fish was considered to have preneoplastic liver lesions (foci of cellular alteration) if histopathology showed the presence of clear cell foci, eosinophilic foci, basophilic foci or biliary hyperplasia. There were no neoplastic liver tumors observed in fish from the REAOC. The only neoplasia observed in the liver was a single adenoma, a benign tumor, in a fish from the OOC reference site. Preneoplastic lesions observed during the microscopic evaluation of livers were found in seven fish from both the REAOC and the OOC reference site. The most commonly observed lesions observed in the livers of fish from both sites were those associated with the presence of various helminth parasites (cestodes, nematodes and digeneans) (Table 1). While there is no difference between the AOC and reference site, as stated earlier, according to Baumann (2010) and Blazer et al (2009), preneoplastic lesions are not a good criteria for carcinogen exposure. The total neoplastic liver tumors observed during the Haynes and Neuderfer study was a single benign adenoma in a brown bullhead from the Oak Orchard Creek reference site. Both the AOC and reference site neoplastic tumor liver incidence is below the proposed rate evidence of impairment guidance values of five to seven percent (Baumann 2000).

Histopathology	Braddock Bay (REAOC) 2010 Number Detected	Oak Orchard Creek (OOC) 2010 Number Detected
Fish (Number examined)	50	50
Removal Criteria #1 Total fish tumors or other deformities		
Parasites (helminths or granulomas from helminthes)	38	39
External abnormalities (Number of fish examined)	7	4
Papillomas	6	1
Epidermal hyperplasia	5	0
Melanoma	1	3
Epidermal erosion	1	1
Ichthyophthirius (focal, severe)	2	0
Digenean (presumptive empty cysts)	1	0
Abnormal tooth formation/ trauma?	2	3
Inflammation	1	3
Total external abnormalities	19	11
Removal Criteria #1 Total fish tumors and other deformities (not liver tumors) (Note: A fish may contain more than one type of tumor or deformity.	64	54
Removal Criteria #2 – Preneoplastic liver tumors		
Total livers with lesions	9	9
Clear Cell focus	1	0

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Histopathology	Braddock Bay (REAOC) 2010 Number Detected	Oak Orchard Creek (OOC) 2010 Number Detected
Eosinophilic focus	6	7
Basophilic focus	1	0
Biliary hyperplasia	4	2
Removal Criteria #2 – neoplastic liver tumors		
Adenoma	0	1
Total Liver Lesions (preneoplastic and neoplastic) in all Fish	12	10

Table 1. Summary of Tumor Incidence (modified after Haynes and Neuderfer 2011)

Haynes and Neuderfer also related the results of the tumor incidence of REAOC to results from an Eighteenmile Creek AOC (EMCAOC) study conducted by Ecology & Environment (E&E) (E&E 2009). Ecology & Environment compared brown bullhead from the EMCAOC to fish from the same Oak Orchard Creek reference site. The same methodologies examining internal and external visual observations were followed (Rafferty and Grazio 2006) and histopathology procedures were performed according to Blazer et al. (2007) to allow comparative analysis between the two studies. The Ecology & Environment study did not report length and weight data for brown bullhead at the EMCAOC and OOC reference area but did provide length-frequency data. Since there were no significant differences in length among the study sites REAOC and EMCAOC and OOC reference area (E&E 2009), it was assumed that brown bullheads were similar in size and age between the two studies. Statistical analysis using the Chi-square tests for heterogeneity or independence were performed to test the null hypothesis that there were no significant differences in the prevalence of proliferative liver lesions and liver parasites among the brown bullheads from the three sites and between the two studies (years). The results demonstrate that there is no significant difference ($P=2.02$) in the incidence of proliferative liver lesions between sites and studies (years). No internal malignant tumors were observed in any of the sectioned tissues from the bullhead and there were no significant differences in fish health as measured by hepatic neoplasia from both studies (Table 2).

	2010 REAOC	2010 OOC	2007 OOC	2007 EMC AOC
Livers with lesions	9	9	16	15
Altered foci (total)	8	7	13	10
Biliary hyperplasia (total)	4	2	0	4
Adenoma (total)	0	1	2	2

Livers with parasites	38	39	17	28
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Table 2. Proliferative lesions and parasites in livers of brown bullheads collected in 2010 and 2007 at the Rochester Embayment and Eighteenmile Creek AOCs and the Oak Orchard Creek reference area (after Haynes and Neuderfer 2011).

The Haynes and Neuderfer (2011) study has demonstrated there was no significant difference in the prevalence of tumors or lesions in the bullheads from Rochester AOC when compared to the Oak Orchard Creek reference site and satisfied specific delisting targets proposed. ‘Chi-square tests for heterogeneity or independence were used to test null hypotheses that there were no significant differences in the prevalence of proliferative liver lesions and liver parasites among the same brown bullheads.’ ‘Incidences were low and there were no significant differences (P=0.202) in proliferative liver lesions in brown bullheads at the four study locations.’ (Haynes, 2011). The Rochester AOC study has also demonstrated lower prevalence than the Eighteenmile Creek AOC; therefore the Tumors BUI should be removed from the AOC. A full discussion and explanation of the Haynes and Neuderfer (2011) study is found in Appendix E.

Environmental Conditions.

All major industrial discharges of concern have been eliminated through administrative and clean up measures including, source control activities and other remedial actions. There are still low levels of contaminants in the river sediment that are possibly may be due to other incidental or residual sources that are not managed or are unregulated. Sediment chemistry specific to PAHs have been evaluated in the Genesee River (NYSDEC 2007, USEPA 2012). Results of PAH concentrations were compared to the threshold effects concentration (TEC); below which adverse effects are not expected to occur in benthos and to the probable effect concentration (PEC) above which adverse effects are likely. (MacDonald et al 2000).). The Genesee River Characterization study (USEPA2012) results indicate PAH concentrations in surface sediments rarely exceed the PAH TEC of 1610 ug/kg and none of the PAH results observed were above the probable effects threshold PEC of 22800 ug/kg exist in the Genesee River. Only one sample was collected from a marina outside the river channel was above the PAH TEC (USEPA 2012). This location is currently under remedial management as part of, the New York State Brownfield Cleanup Program. Additionally, core samples from demonstrated that subsurface concentrations tended to be higher than surface concentrations suggesting PAH contamination is decreasing (USEPA2012). It’s believed clean sediments are covering more contaminated sediments and are reducing the exposure pathway. These clean sediments are a result of management practices, infrastructure improvements and educational awareness. Table 3 summarizes levels of PAH’s found in the river in recent sampling done by USEPA (USEPA 2012). Manufactured gas plant (MGP) sites and a landfill site identified as sources of polycyclic aromatic hydrocarbons (PAHs) were among these sources. These sites, located upstream and outside of the AOC on the Genesee River, have likely contributed to the PAH contamination found within the AOC.

Segment Interval	Quantity of Samples	Quantity of Data Points	Concentration (µg/kg)			Standard Deviation	Location of Maximum	Percent above TEC (1610 µg/kg)	Percent above PEC (22,800 µg/kg)
			Minimum	Maximum	Mean				
0-0.5	9	9	526	16739	3200	5142	GR-31	56	0
0-3	25	25	739	29083	3157	5541	GR-13	60	4
3-6	19	19	1189	15048	2765	3062	GR-13	79	0
6-9	19	19	16.8	6585	2675	1927	GR-01	74	0
9-12	13	13	19.5	15490	4411	4034	GR-01	77	0
12-15	11	11	16.7	20670	6137	6545	GR-16	82	0
15-18	4	4	9.90	10330	3108	4898	GR-22	50	0
18+	1	1	35.6	35.6	NA	NA	GR-16	0	0

Table 3. Total PAHs – Statistical Summary

While the literature, including the Presque Isle Bay AOC Stage III report, is unclear as to the significance of PAH causality to fish tumors it is important to cleanup these contaminant types and other Hazardous Waste Sites, all of which are assumed beneficial to removing the BUI. Presently the MGP sites are participating in the New York State Voluntary Cleanup Program and all four have initiated remedial measures to clean up contaminants. In addition non-point source input of PAHs as well as other pollutants was reduced as a result of the Combined Sewer Overflow Abatement Program. The following is a brief summary of the activities addressing sources of PAHs.

- The Front Street former manufactured gas plant (MGP) was constructed in 1848 and operated until about 1879. From 1879 to 1926, the site was used as an operations facility. In 1938, a newer operations and maintenance facility was constructed which operated until 1994. The above ground structures were demolished in 2000. Environmental investigations and a remedial investigation took place at the site from 1988 to 2004. An interim remedial measure (IRM) was conducted in 1999, which included grouting up the river bank to prevent seeps. Inspection of the river bank area is conducted annually. The site Remedial Investigation Report was approved in 2007. The Decision Document and Remedial Action Selection Submittal were approved on June 4, 2010.
- The East Station former MGP site was constructed in 1872, and operated until the 1950's. The site had several holding tanks and gas manufacturing buildings which have since been demolished and the foundations filled in. In 1992, a preliminary site assessment was conducted. In 1998, a focused remedial investigation (RI) was conducted, that found coal tar and coal tar contaminated soil/waste on site and coal tar seeps into the adjacent Genesee River were observed. In 2005, RG&E conducted an IRM to remove a subsurface container. In 2008, a second IRM was conducted by RG&E to stabilize onsite contaminated soils. This IRM included removal of waste, construction of a barrier wall and a non-aqueous phase liquid (NAPL) collection system to prevent coal tar seeps into the Genesee River. A site wide RI was done in 2011, which included test pits and installing both overburden and bedrock observation wells.
- The West Station former MGP site operated from about 1910 to 1952. Later, the site was used as a large coal-fired power generating facility (Beebe Station) which was removed from service in 1999.

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An IRM was conducted to the south of the site in 1994, which resulted in a covered consolidation area for coal tar contaminated soils. In 2004, coal tar emanating from the West Station MGP was identified in the Genesee River. A Remedial Investigation/Feasibility Study (RI/FS) work plan was approved in August 2008, and the first phase of field work was conducted in the fall of 2008. A supplemental phase 2 work plan was approved in October 2009, with field work conducted that same fall. An RI summary report was submitted in 2010, and FS is presently underway. Additional off-site investigations are underway.

- The Brewer Street landfill is located in the Genesee River gorge adjacent to the Middle Falls hydroelectric power plant dam. During construction of a sewer tunnel in 1984 and 1985, coal tar was encountered in the bedrock. Two settling lagoons were constructed to separate coal tars from the water that was pumped out of the tunnel during construction. In 1985, the lagoons were closed in-place. The outfall of the lagoons discharged to a wetland adjacent to the Genesee River. In 1998, an on-site investigation of groundwater, soil, and river sediments revealed dense non-aqueous phase liquid (DNAPL) in groundwater, coal tars in soils, coal tar contamination in the river sediments behind the Middle Falls dam and DNAPL seeps at the base of the Middle Falls dam flood gates and middle falls rock face. In 2003, approximately 62,195 tons of contaminated soil, river sediment, and bedrock was excavated and disposed off-site. A final engineering report was completed in 2004. The site was backfilled with clean fill and regraded. After the removal action, persistent seeps of DNAPL at the base of the Middle Falls dam required additional remediation. Remedial actions to mitigate the DNAPL seeps were taken, which consisted of bedrock grouting and a new concrete spillway over the easternmost portion of the middle falls dam and rock ledge was constructed and completed in fall of 2007. Recent follow-up inspections do not show evidence of DNAPL seeps into the Genesee River. A site management plan to manage residual contamination and a deed restriction limiting site access and use was approved in 2009, and filed in April 2010 with the Monroe County Clerk.
- Additional Non-Point sources of PAH's include fossil fuels, incomplete combustion, especially from two-cycle motors, and more recently, from coal tar based driveway sealers. PAH's derived from many of these currently used and un-regulated sources are carried to receiving streams as a component of non-point source pollution (USGS 2011). Prior to the 1980's, it is probable that a portion of the loading to the Genesee River and the nearshore of the Rochester Embayment was delivered as part of the discharges from the combined sewer system serving the urban core of the City of Rochester. However, in the 1970's and 1980's, modernization of the Rochester Sewer District System including construction of the deep tunnel storage system known as the Combined Sewer Overflow Abatement Program (CSOAP), removed a significant portion of the City of Rochester from drainage to the Genesee River, instead sending the combined storm and sanitary wastes from most of the City to the Frank E VanLare Waste Water Treatment Plant. This storage system, consisting of over 30 miles of tunnels and combined capacity of 175 million gallons of wastewater, has resulted in the phase out of over 30 discharge points, mainly to the Genesee River, and has eliminated an estimated average of 3.75 billion gallons of combined sewage discharges per year since its full implementation in 1993, ~~and~~. It has also reduced discharge points to 15 which has reduced discharge to the River from 50-70 wet weather events per year to an average of one to two per discharge point (MCDES 2004).

C. Criteria, Principles and Guidance Application

The intent of the RAP process is to remedy the impairment (and cause) when the AOC is the source of the impairment or an upstream source is contributing to a known impairment in the AOC. Each of the Delisting Criteria for the Fish Tumor and other Deformities impairment is met in the following manner:

1. Incidence rates of fish tumors or other deformities do not exceed rates at non-AOC control sites.

In conformance with the RAP Criteria for this BUI, and in light of the serious disagreement in the scientific community about other indicators such as external deformities, the RAC has determined that neoplastic liver tumor incidence is the only measurable endpoint for delisting.

The 2011 SUNY Brockport study examining fish captured in 2010 determined that the prevalence and severity of internal and external deformities in bullhead from the Rochester Embayment AOC were not statistically different than the Oak Orchard Creek control site and the brown bullheads caught within the AOC did not exhibit neoplastic liver tumors. Additionally there was no statistical difference in the incidence of liver tumors between the AOC and the control site. Tumor prevalence in the Rochester Embayment AOC was also lower than the Eighteen Mile Creek AOC which was not listed for this BUI as a result of the findings of the E+E study.

2. Survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullhead or suckers.

Language for listing this impairment provided by the IJC states "When the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullheads or suckers." Language for delisting, now called 'removal', of this BUI states, "When the incidence rates of fish tumors or other deformities do not exceed rates at unimpacted control sites and when survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullheads or suckers." While many readers interpret "survey" to mean "requesting information from users of the resource and responsible agencies," many readers question whether this meaning can be correct. Detection of neoplastic and preneoplastic deformities of the liver of bullheads is not something likely to be within the skill set of the average angler or person who would come into casual contact with brown bullheads, as it requires careful collection of specimens, isolation of the livers, careful dissection and preservation of tissues in the field, and microscopic examination by trained personnel in the laboratory. An alternate definition of survey is "to view in detail, especially to inspect, examine, or appraise formally or officially in order to ascertain condition, value, etc" which would conform to the process for examination of Bullhead livers specified in the literature. Results of this type of survey are those detailed in the previous discussions, and indicate that the BUI can be removed. It is the opinion of the RAC that a survey of tumor rates from the general public would be biased and unreliable to be used as a reliable source of information.

In terms of the definition of survey as "requesting information about a subject," action has also been taken in this process. While there is no formal tracking system in place, a survey of NYSDEC Fishery Managers from Regions around Lake Ontario was taken; they reported no incidences of brown bullheads with tumors or other deformities from trained NYSDEC field personnel or the general public in recent times.

D. Removal Statement

The Haynes and Neuderfer (2011-SUNY-Brookport study) study has demonstrated there was no significant difference in the prevalence of neoplastic tumors or lesions in the bullheads from Rochester AOC when compared to the Oak Orchard Creek reference site (P=0.202) and satisfied specific delisting targets proposed. The study also demonstrated a brown bullhead liver neoplastic tumor incidence rate of 0% in the REAOC. This rate did not substantively differ from the liver tumor incidence observed at the Oak Orchard Creek reference site (0.02%) and was well below the guidance values of 5-7% tumor rates observed in other US surveys. The presence of preneoplastic lesions were noted in the AOC at rates no different than the reference site OOC. The use the preneoplasm results are not considered when determining the status of the BUI because there is a need for further research to determine which lesions are a result of anthropogenic carcinogens and progress to neoplasms. Nevertheless, because of the data collected and uncertainty of the research to date regarding carcinogenic exposure, additional lines of evidence of PAHs were presented. The probable effect concentration (PEC) targets are mostly met across the AOC for PAHs. Exceedences do occur but in limited areas and not AOC-wide and these sources of PAHs are all under active management by New York State Remedial programs. These lines of evidence indicate the endpoint for the Fish Tumor and Other Deformities BUI is met. Accordingly, the liver tumor incidence rate in the Rochester Embayment AOC meets the IJC impairment criterion: "when BUI endpoint to demonstrate that the incidence rates of fish tumors or other deformities do not exceed rates at unimpacted control sites or when survey data confirm the absence of neoplastic or preneoplastic liver lesions in bullheads or suckers" (IJC, 1991) and complies with neoplastic tumors occurring in the Rochester Embayment RAP Stage II restoration target that: 1. Incidence rates of fish tumors or other deformities do not exceed AOC are no greater than incidence rates at non-AOC control sites; and 2. "Survey data confirm that the absence of bullheads or suckers from the AOC are neoplastic or preneoplastic liver tumors in bullhead or suckers. tumor free

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IV. BUI Removal (Delisting) Steps and Follow-up

A. BUI Removal Steps

Finished	Date	Step taken
1. ✓	12/08	Delisting criteria completed and finalized with USEPA
2. ✓	1/12	Original impaired conditioned reviewed to identify causes and sources
3. ✓	2/12	Review of technical information assembled and data synthesis conducted
4. ✓	3/12	RAP advisory committee discussed endpoint for BUI based on criteria

5. ✓ 4/12 Expert involvement and development of supporting statements performed
6. ✓ 8/12 Additional/ related monitoring, data review and assessment conducted
7. ✓ 8/12 Discussion of removal by RAP advisory / oversight committee
8. ✓ 9/12 Collaboration with USEPA and NYSDEC for draft technical report preparation
9. ✓ 5/13 Public meeting held, information, outreach, and comment on removal conducted (included a 30-day public comment period)
10. ✓ 6/13 Comments assembled, Re-drafted BUI removal report prepared to include necessary changes
11. ✓ 7/13 Monroe County and NYSDEC (in consultation with USEPA R2) completes final modifications to the Fish Tumors and Other Deformities BUI removal document.
12. 8/13 Coordinate the formal transmittal of the BUI removal (delisting) with USEPA GLNPO. Communicate result with IJC.
13. 9/13 Communicate results to local RAP Coordination for appropriate recognition and follow-up.

B. Post (delisting) Removal Responsibilities

Post- delisting activities are to be conducted by responsible parties identified to implement the actions that are to address the remaining concerns of the BUI removal process. The following organizations are to continue ongoing environmental program activities to assure protection of the beneficial uses:

1. **Monroe County Department of Health** - provide oversight for the RAP Coordination process and the drinking water conditions in the Area of Concern and its watershed. Report to local governments and public organizations on issues and concerns regarding drinking water. Seek to take corrective action to prevent issues and protect long term health.

2. **New York State Department of Environmental Conservation** – provide technical assistance to the oversight for RAP Coordination and restoration and protection of beneficial uses in the AOC and its watershed.
3. **United States Environmental Protection Agency** – continue to assist RAP Coordination in the Rochester Embayment AOC to achieve the long-term goal of delisting the entire AOC.
4. **Lake Ontario Coastal Initiative (LOCI)** – is a partnership of the Center for Environmental Information (CEI), Finger Lakes-Lake Ontario Watershed Protection Alliance and SUNY Brockport. The Partners continue in its goal to restore the ecological integrity of New York’s 300 miles of southern and eastern shoreline, embayments, river and creek mouths, wetlands and ponds of Lake Ontario, which is key to the region's economic vitality. Actions are to address public commitment, mitigation measures, land use, habitat protection; and water quality research.
5. **Lake Ontario Lakewide Management Plan (LAMP)** - Report on use impairment indicator monitoring of beneficial uses as developed and documented by the state, provincial, and federal governmental (United States and Canada) Workgroup and Management Committee. Continue to develop and implement the work plan for the restoration and protection of beneficial uses for the lake, nearshore areas, and the drainage basin.
6. **Other Local Environmental Protection and Action Organizations:**
 - a. **Monroe County Soil and Water Conservation District (SWCD)** - Continue implementation projects to protect against erosion and provide stream bank protection and best management practices as resources permit. Assist NYSDEC in monitoring and surveillance activities for improved water quality. Implement SWCD’s mission to protect, promote, and improve natural resources. Continue to work with land users to educate and encourage actions that mitigate erosion and runoff.
 - b. **Monroe County Department of Planning and Development** - Implement actions to further the protection and planned development of the lands around the Genesee River. Maintain a healthy balance between environmental and economic interests.
 - c. **Monroe County Water Quality Coordinating Committee** - Work to maintain and restore the quality of Monroe County’s water resources, through a cooperative, coordinated manner which includes educational and technical efforts. Coordinate activities with Monroe County’s Water Education Collaborative.
 - d. **Monroe County Environmental Management Council** - Work, with citizen support and county governments, to achieve environmental goals of the local community in conjunction with the county government.
 - e. **Center for Environmental Initiatives (CEI) – Along with the** Lake Ontario Coastal Initiative (LOCI) spearhead the continued strategic planning for development and implementation activities. Work with its partners, the Finger Lakes-Lake Ontario Water Protection Alliance (FL-LOWPA), SUNY Brockport Department of Environmental Sciences and Biology, and the LOCI Steering committee, representing public and private stakeholders

to remediate, restore, protect and sustain the Lake Ontario, New York Great Lakes Coastal region including the St. Lawrence River.

- f. **Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA)** – Work to foster and expand a collaborative, watershed based approach to water quality protection and enhancement in the Lake Ontario watershed; assists local counties with funding for projects for watershed protection.

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V. Appendices

Appendix A.

RAP Oversight Committee

Charles Knauf, Chair, Rap Coordinator
Jayme Breschard, Genesee Finger Lake Regional Planning Council
Ray Yacuzzo, New York State Department of Environmental Conservation
Wayne Howard, Great Lakes Committee Chair, the Sierra Club
Jeff Wyatt, DVM, University of Rochester Medical Center; Seneca Park Zoo
Chris Fredette, Rochester Committee for Scientific Information
Charles Valeska, Town of Irondequoit Conservation Board, formerly Eastman Kodak Company
Stevie Adams, The Nature Conservancy
George Thomas, Center for Environmental Initiatives
John Waud, Rochester Institute of Technology
Louise Hartshorn, Monroe County Environmental Management Council
Mark Gregor, City of Rochester
Paul Sawyko, Water Education Collaborative
June Summers, Genesee Valley Audubon Society

RAP Technical Committee**Charles L. Knauf****Rochester Embayment Remedial Action Plan Coordinator**

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Barbara Belasco (ret 6/2013)

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Lake Ontario Program Manager
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Alicia Reinmund –Martinez (as of 7/2013)

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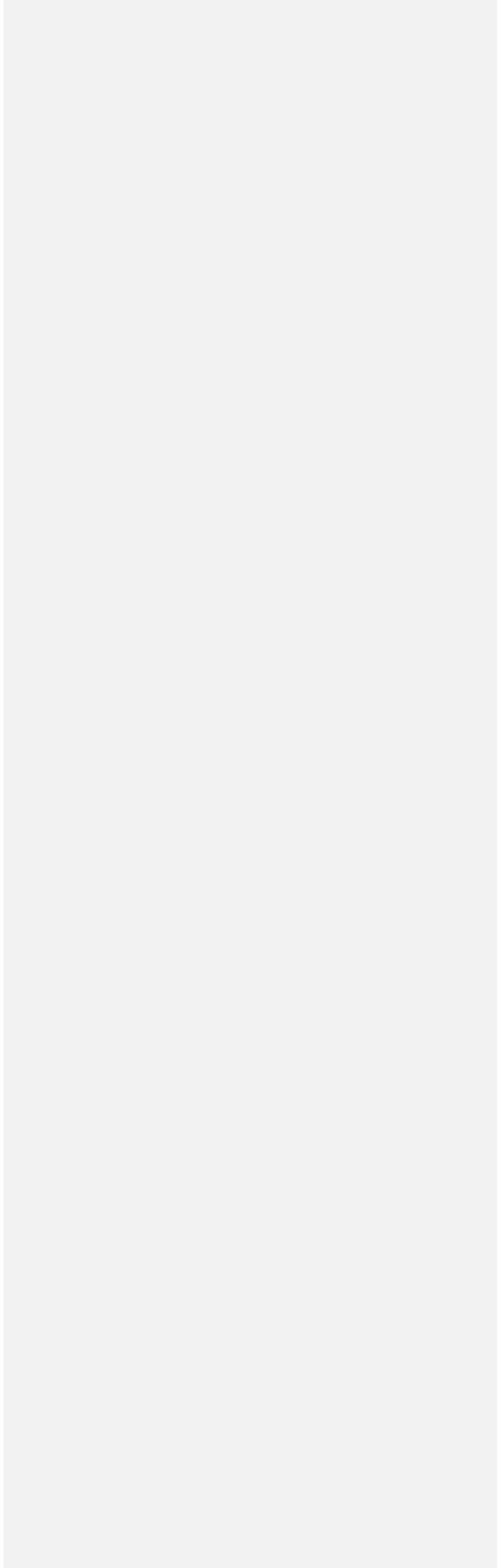
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Christopher Fidler

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Division of Water
Fisheries Biologist Region 6

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Appendix B.



Hazardous Waste Facility Factsheets



New York State Department of Environmental Conservation

FACT SHEET

Voluntary Cleanup Program

RG&E Front Street Site
Site No. V00073-8
City of Rochester, Monroe County, NY

April 2010

Remedy Proposed for Voluntary Cleanup Program Site Contamination; Public Comment Period and Public Meeting Announced

The public is invited to comment on a proposed remedy being reviewed by the New York State Department of Environmental Conservation (NYSDEC) to address contamination related to the RG&E Front Street Site ("site") located at the corner of Front and Andrews Street in the City of Rochester, Monroe County. See map for site location.

The Proposed Remedy

The cleanup remedy proposed for the site includes excavating coal tar impacted subsurface soils as well as impacted surface materials to facilitate installation of a clean soil cover. RG&E developed the proposed remedy after performing a detailed investigation of the site under New York's Voluntary Cleanup Program (VCP).

The proposed remedy is described in a draft cleanup plan called a "Remedial Action Alternative Selection Submittal" (RAAS) and in an accompanying draft Decision Document prepared by NYSDEC. The RAAS and Draft Decision Document are available for review at the Central Library of Rochester – Rundel Library and NYSDEC's Region 8 Office identified below under "Where to Find Information".

Public Meeting
Thursday, April 29, 2010
7:00PM

Brockport Metro Center
Golden Eagle Conference Room, 2nd floor
55 St. Paul St., Rochester, New York

NYSDEC invites you to a public meeting to discuss the proposed remedy to address contamination at the site. You are encouraged to provide comments at the meeting, and during the 30-day comment period described in this fact sheet.

How to Comment

Voluntary Cleanup Program: New York's Voluntary Cleanup Program (VCP) was developed to encourage private sector volunteers to investigate and clean up contaminated properties and return these sites to productive use. Once cleaned up, the properties may be redeveloped for commercial, industrial, residential or public use.

For more information about the VCP, visit:
www.dec.ny.gov/chemical/8442.html

NYSDEC is accepting written public comments about the proposed remedy for 30 days, from April 21, 2010 through May 21, 2010.

Submit written comments to:

Mr. Salvatore F. Priore, P.E.
N.Y.S. Department of Environmental Conservation
Division of Environmental Remediation
11th Floor, 625 Broadway
Albany, New York 12233-7014
E-mail: sfpriore@gw.dec.state.ny.us

New York State Department of Environmental Conservation



FACT SHEET

July 2003



Monroe County and Rochester Gas & Electric Begin Cleanup at Brewer Street Site

In July 2002, Monroe County and Rochester Gas and Electric (RG&E) signed a voluntary agreement with the New York State Department of Environmental Conservation (DEC) to perform an environmental investigation and cleanup at the Brewer Street site in the City of Rochester (see map). The investigation and remediation are being conducted through New York State's Voluntary Cleanup Program (see box at right).

The DEC is providing this fact sheet to explain highlights of the site cleanup and how to get more information.

What Happens Next:

A remediation work plan was developed and it provides the details for excavation and removal of contaminated sediments and soils at the Brewer Street Site. It also includes a health and safety plan to address worker and community safety. Implementation of the remediation will take approximately 4 months. The first phase of work started the week of June 16, 2003 and includes preparation of access roads to the site. The next phase of construction begins during the first week of July and involves construction of a cofferdam in the Genesee River. A cofferdam is a temporary dam that will allow construction crews to excavate the river sediments below the level of the river. Once the cofferdam is in place and the river level is dropped, excavation of contaminated sediments and soils will begin. During this phase, air quality will be monitored and all reasonable efforts will be made to control

NEW YORK STATE'S VOLUNTARY CLEANUP PROGRAM

The New York State Department of Environmental Conservation's Voluntary Cleanup Program promotes the return of contaminated property to productive use. These include sites contaminated by hazardous waste, petroleum, and solid waste.

Under this program, a person or entity (such as a corporation) agrees to pay for an investigation and/or environmental cleanup of the site. If the volunteer performs a cleanup of the site, the volunteer receives a limited release from liability for past environmental damage at the site.

odors that may be generated from excavation of river sediments and contaminated soils. A NYSDEC representative will be on-site for most of these excavations. Upon completion of excavations, the site will be backfilled with clean soils and seeded. The temporary cofferdam will be removed and the site will be monitored to determine the effectiveness of the cleanup. Please refer to the remediation work plan at either of the document repositories identified below.

About the Brewer Street Site:

This site is located in the Genesee River Gorge

adjacent to the middle falls in the City of Rochester, Monroe County. The site is currently owned by RG&E. In 1984 and 1985, Monroe County used a portion of the site under an easement granted by RG&E during the construction of the Cliff Street Siphon Tunnel Project. During sewer tunnel construction, coal tar was encountered. To facilitate construction of the sewer tunnel, two settling lagoons were constructed on-site to separate coal tars from water that was pumped out of the tunnel. The outfall of the lagoons discharged to a wetland adjacent to the Genesee River (the marsh area). Contaminants settled in the base of the lagoons and apparently leaked into the surrounding soils. The lagoons were closed in-place in 1985. Closure activities included excavation of visibly contaminated soils from several areas of the site. The property is currently vacant. RG&E and Monroe County (the Volunteers) conducted an extensive on-site investigation of groundwater, soil and river sediments in 1998 without NYSDEC oversight. This investigation included installation of 21 groundwater monitoring wells, numerous test pits and soil samples, and 27 river sediment and marsh sediment samples. The results of the investigation indicated coal tar product and constituents in groundwater, soils, and river sediments. Coal tar seeps (discharges coming from the ground) were noted at the base of the middle falls dam floodgate. For definition purposes, coal tar is a generic term for wastes generated from a coal gasification plant. Most coal gasification plants in the northeastern United States ceased operation in the 1950s with the advent of natural gas pipelines. Today, coal tar is commonly found in such products as driveway sealers and dandruff shampoos.

Public water and sewers are used in the area. There are no known private drinking water wells in the vicinity of the site.

Details of the Investigation:

The purpose of the investigation was to further define the nature and extent of contamination at the site. The investigation was completed in 2001, and the report was submitted to the Department in early 2002. This investigation supplemented the existing data and included the following activities: installation of additional monitoring wells; sampling new and existing wells; and sampling of soil and sediment to characterize the extent of contamination in the adjacent marsh area and the Genesee River. Downstream off-site monitoring wells were not installed due to physical barriers at the site (the middle falls, the river, and steep gorge walls).

The results of investigations confirmed previous sampling and identified an area of sediment in the Genesee River and soils in the former lagoon area which would require removal. Coal tar seeps were noted at the base of the dam and along the ledge of the middle falls. The Volunteers installed a temporary barrier to mitigate further seeps into the Genesee River along the ledge of the middle falls.

For More Information:

DEC will keep you informed of progress at the site through fact sheets like this one. If enough interest is expressed, the State will hold a public meeting to discuss the upcoming activities at this site. You can express your interest in attending such a meeting by calling one of the people listed below or by sending in the attached mailer.

Because our mailing list includes property owners of businesses and apartments, we encourage you and the building owners to share this fact sheet with neighbors and tenants, and/or post this fact sheet in a prominent area of your building for tenants, employees, and visitors to view

The remediation work plan and other documents related to the site cleanup and investigation are available for you to review at the following document repositories:

NYS Department of Environmental Conservation Region 8 Office 6274 East Avon-Lima Rd. Avon, New York 14414-9519 <i>Hours:</i> Monday- Friday 8:30 - 4:45 by appointment only <i>Contact:</i> Lisa LoMaestro Silvestri (585) 226-5326	Rochester Public Library - Lincoln Branch 851 Joseph Avenue Rochester, New York 14621 <i>Hours:</i> Monday and Wednesday, 10:00 am - 7:00 pm Tuesday and Thursday, Noon - 8:00 pm Friday, 11:00 am - 6:00 pm Saturday, Noon - 5:00 pm <i>Contact:</i> Joan Lee, Reference Librarian
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We encourage you to contact the representatives listed below with questions, comments or concerns. If you know someone who would like to be added to the mailing list, have them send in the attached mailer or contact one of the people listed below. You do **not** have to return the mailer if you received this fact sheet in the mail; your name will automatically remain on the mailing list.

• **For Question About the Investigation, Contact:**

Todd M. Caffoe, P.E., Project Manager (585) 226-5350 or
Lisa A. LoMaestro-Silvestri, Citizen Participation Specialist (585) 226-5326
NYS Department of Environmental Conservation
6274 East Avon-Lima Road
Avon, NY 14414-9519

• **For Site-Related Health Questions, Contact:**

Charlotte Bethoney NYS Department of Health Flanigan Square 547 River Street Troy, NY 12180 (800) 458-1158 ext. 27860 or (518) 402-7860	Joseph Albert Monroe County Health Department 111 Westfall Road - PO Box 92832 Rochester NY 14692 (585) 274-6904
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FACT SHEET

December 2004



Notice of Upcoming Environmental Remedial Activities at RG&E's Former East Station Manufactured Gas Plant Site, Rochester N.Y.

Rochester Gas and Electric (RG&E) has signed a Voluntary Cleanup Agreement with the New York State Department of Environmental Conservation (NYSDEC) to perform environmental investigations and cleanup at the company's property located at 86 Smith Street (referred to as the Former East Station Site) in the City of Rochester (see Figure-1). The work is being conducted through New York State's Voluntary Cleanup Program (see box to the right).

The NYSDEC, in conjunction with the New York State Department of Health (NYSDOH) and the Monroe County Health Department (MCHD) are providing this fact sheet to explain upcoming remedial activities and how to get more information.

NEW YORK STATE'S VOLUNTARY CLEANUP PROGRAM

New York's Voluntary Cleanup Program was developed to enhance private sector cleanup of properties by enabling businesses to investigate and cleanup sites using private rather than public funds. The investigation and cleanup are carried out under the oversight of NYSDEC and NYSDOH. When the volunteer completes the work, the State provides a release from State liability for the work done.

Introduction

RG&E has been investigating and assessing environmental remediation needs for its Former East Station Manufactured Gas Plant (MGP) site located in Rochester, New York. RG&E and the NYSDEC have agreed that an Interim Remedial Measure (IRM) should be performed. An IRM consists of cleanup actions that can be conducted at a site relatively quickly to remove a source area of contamination from a well-defined area. This IRM project is targeted to begin in early to mid December 2004, weather permitting.

The IRM will involve the removal of a subsurface gas holder/tar well that remains at the site and excavation of soil around the holder foundation. The excavation and removal work will be completed in accordance with an IRM Work Plan that was developed by RG&E and was approved by NYSDEC, and NYSDOH.

About the RG&E East Station Site

The Former East Station Site is located along the east side of the Genesee River at the corner of Suntru and Smith Street, just west of the intersection of St. Paul Street and Smith Street. The majority of the Site is vacant with the exception of four buildings currently used by RG&E that are located along the northern portion of the property.

The site is the location of a former manufactured gas plant (MGP) that was constructed by the Citizen's Gas Company (a predecessor company to RG&E) in 1872. Coal gas manufacturing operations ceased at the site in 1917, at which time the MGP was used primarily to purify coal gas that was produced at another MGP. With the advent of natural gas distribution in 1952, the East Station site was modified as a catalytic gas reforming plant, which served to reformulate natural gas, rendering it usable in existing appliances and equipment. This operation ended in 1976 and the plant was demolished.

The manufactured gas was produced by heating coal and other petroleum products in the absence of air (coal carbonization) or in the presence of steam and oil (carbureted water gas). The manufactured gas was used primarily as a lighting, cooking and heating supply. Byproducts of the manufactured gas process often remained at former MGP sites when plants were closed. These byproducts can include coal tar, purifier wastes and coal ash. Chemicals associated with these coal tar residues and purifier wastes include polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), which are the focus of the IRM cleanup.

Planned IRM Work

The IRM is estimated to take eight to ten weeks to complete, depending on the weather conditions. Site preparation activities are targeted to begin the first part of December 2004, with the actual removal activities targeted to commence around the week of December 27, 2004. Subsurface sampling activities, consisting of soil borings and test pits were performed in October 2004.

To implement this IRM, RG&E plans to remove the contents and subsurface structure associated with the former gas holder, as well as some surrounding soil. Excavated material that is impacted by MGP residues will be disposed off-site at permitted facilities.

The IRM work will be performed in accordance with work plans developed by RG&E and reviewed and approved by the NYSDEC and NYSDOH. The IRM Work Plan contains a Health and Safety Plan and a Community Air Monitoring Plan to protect the workers and the public during IRM work at the site. Work activities will generally take place Monday through Friday between 7:00 AM and 6:00 PM.

After completion of the removal action RG&E will prepare an IRM project completion report for review and approval by NYSDEC and NYSDOH. RG&E will continue to work with NYSDEC to design further remedial activities to address other areas of the site, impacted by MGP residuals.

About Manufactured Gas Plants

The East Station site is one of several sites in New York State where manufactured gas was produced for distribution. For a period of over 100 years, MGPs were an important part of life in cities and towns throughout New York State and the U.S. as a whole. They had their beginnings in the early 1800s, and by the 1900s, production had greatly increased to be widely used in residential and industrial settings.

For More Information

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The work plan and other documents related to this investigation are available for your review at the following document repositories:

NYS Department of Environmental
Conservation Region 8 Office
6274 E. Avon-Lima Rd.
Avon, NY 14414
Hours: Monday- Friday 8:30AM - 4:45 PM
Contact: Lisa LoMaestro Silvestri at
(585) 226-5326 for an appointment.

Rochester Public Library, Rundel Branch
4th Floor
115 South Avenue
Phone #: (585) 428-8440
Hours: M & TH 9:00 a.m. - 9:00 p.m.; T, W
& F 9:00 a.m. - 6:00 p.m.; Sat 9:00 a.m. -
5:00 p.m. (closed 6/21 - 9/4); Sun 1:00
p.m. - 5:00 p.m. (October - April)

We encourage you to contact the representatives listed below with questions, comments or concerns. If you know someone who would like to be added to the mailing list, have them send in the attached mailer or contact one of the people listed below. You do **not** have to return the mailer if you received this fact sheet in the mail; your name will automatically remain on the mailing list.

For Questions about the Investigation, Contact:

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NYS Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7014
sfpriore@gw.dec.state.ny.us

Or

Lisa LoMaestro Silvestri, Citizen Participation Specialist, (585) 226-5326
NYS Department of Environmental Conservation
6274 E. Avon-Lima Rd.
Avon, New York 14414-9519

For Site-Related Health Questions, Contact:

Tamara S. Girard
Public Health Specialist
NYS Department of Health, Flanigan Square
547 River Street
Troy, NY 12180
(800) 458-1158 ext. 27860 or (518) 402-7860

RG&E Contact:

Richard Marion at RG&E at (585) 771-4802



FACT SHEET

March, 2006



Environmental Investigation Begins at RG&E's Former West Station Manufactured Gas Plant, Rochester, N.Y. Site # V00593-8

Rochester Gas and Electric (RG&E) has signed a Voluntary Cleanup Agreement (VCA) (April 20, 2003) with the New York State Department of Environmental Conservation (NYSDEC) to investigate and clean up at the RG&E's property located at 254 Mill Street (referred to as the Former West Station Site) in the City of Rochester. (see Figure-1) The work is being conducted through New York State's Voluntary Cleanup Program (see box to the right).

The NYSDEC, in conjunction with the New York State Department of Health (NYSDOH) and the Monroe County Health Department are providing this fact sheet to explain upcoming field work and remedial activities beginning in April and how to get more information.

NEW YORK STATE'S VOLUNTARY CLEANUP PROGRAM

New York's Voluntary Cleanup Program was developed to enhance private sector cleanup of properties by enabling businesses to investigate and clean up sites using private rather than public funds. The investigation and cleanup are carried out under the oversight of NYSDEC and NYSDOH. When the volunteer completes the work, the State provides a release from liability for the work done.

Introduction

RG&E has been investigating and assessing environmental remediation needs for the "plant area" of its West Station Former Manufactured Gas Plant (MGP) site in Rochester. RG&E and the NYSDEC have agreed that an investigation in the area of a reported oil-tar separator should be performed to determine if it is present, and to assess its integrity and need to remove it as an Interim Remedial Measure (IRM). An IRM consists of a cleanup that can be conducted at a site relatively quickly to remove a source area of contamination from a well-defined area. The investigation phase of the project is targeted to begin around April 2006, weather permitting.

The initial investigation phase of the project will involve the excavation of test pits and drilling of soil borings and installation of groundwater monitoring wells. The work will be completed in accordance with a work plan entitled *Work Plan for Characterization and Design of an Interim Remedial Measure for the Oil Tar Separator Area* (February 2006) that was developed by RG&E and approved by NYSDEC and NYSDOH. The work plan for this investigation at this site is available at the document repositories listed below.

About the RG&E West Station Site

The West Station Site is located along the west side of the Genesee River at the end of Falls Street, east of Mill Street and north of the Platt Street Bridge. (See attached map). The majority of the site is occupied with buildings that supported the operations of the former Beebe Station electrical generating facility which ceased operation in 1999. The site and buildings are currently used for distribution of high voltage electrical circuits and peak load electrical generation equipment.

The site is the location of a former MGP that was constructed by the Rochester Railway and Light Company (a predecessor company to RG&E). Operations began at the site in 1916/17 and continued until 1952 when natural gas became available in the Rochester area. From 1952 until 1961 the gas manufacturing facilities were dismantled and four remaining buildings were converted for other purposes to support RG&E operations. In 1996 RG&E completed remediation at a portion of the West Station site referred to as the "park area" in accordance with a VCA specific to that remedial action (VCA Index# D8-0001-95-10).

Manufactured gas was produced by heating coal and other petroleum products in the absence of air (coal carbonization) or in the presence of steam and oil (carbureted water gas). Both processes were used at the West Station site. The manufactured gas was used primarily for lighting, cooking and heating. Byproducts of the manufactured gas process often remained at former MGP sites when plants were closed. These byproducts can include coal tar, purifier wastes and coal ash. Chemicals associated with these coal tar residues and purifier wastes include polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs) which are the focus of the characterization.

Planned IRM Work

To implement the initial investigation phase of the work plan, RG&E plans to complete soil borings, install ground water monitoring wells and excavate test pits to examine the integrity and contents of the below grade oil-tar separator (if present), and surrounding soil.

The work will be performed in accordance with the work plan developed by RG&E and reviewed and approved by the NYSDEC and NYSDOH. The project work plan contains a Health and Safety Plan and a Community Air Monitoring Plan to protect the workers and the public during project field work at the site. Work activities will generally take place Monday through Friday between 7 a.m. and 6 p.m.

The initial investigation phase of the project (including field work and reporting) is anticipated to take 10 to 12 weeks. The initial field work is anticipated to take 5 to 7 days and is scheduled to commence the first week of April 2006, weather permitting.

After completion of the investigation field activities, RG&E will prepare a summary report and data package for review and approval by NYSDEC and NYSDOH. Based on the conclusions of the initial investigation phase of the project and further discussion with the NYSDEC, it will be determined if RG&E will develop and submit an addendum IRM work plan for the removal of the oil-tar separator.

About Manufactured Gas Plants

The West Station site is one of several sites in New York State where manufactured gas was produced for distribution. For a period of over 100 years, MGP's were an important part of life in cities and towns throughout New York State and the U.S. as a whole. They had their beginnings in the early 1800s, and by the 1900s, production had greatly increased to be widely used in residential and industrial settings.

For More Information

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Rochester Public Library, Rundel Branch
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& F 9 a.m. - 6 p.m.; Sat 9 a.m. –
5 p.m. (closed 6/21 - 9/4); Sun 1
p.m. - 5 p.m. (October – April)

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NYS Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7014
sfpriore@gw.dec.state.ny.us
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1-888-459-8667-- toll free -- Albany

Or

Lisa LoMaestro Silvestri, Citizen Participation Specialist,
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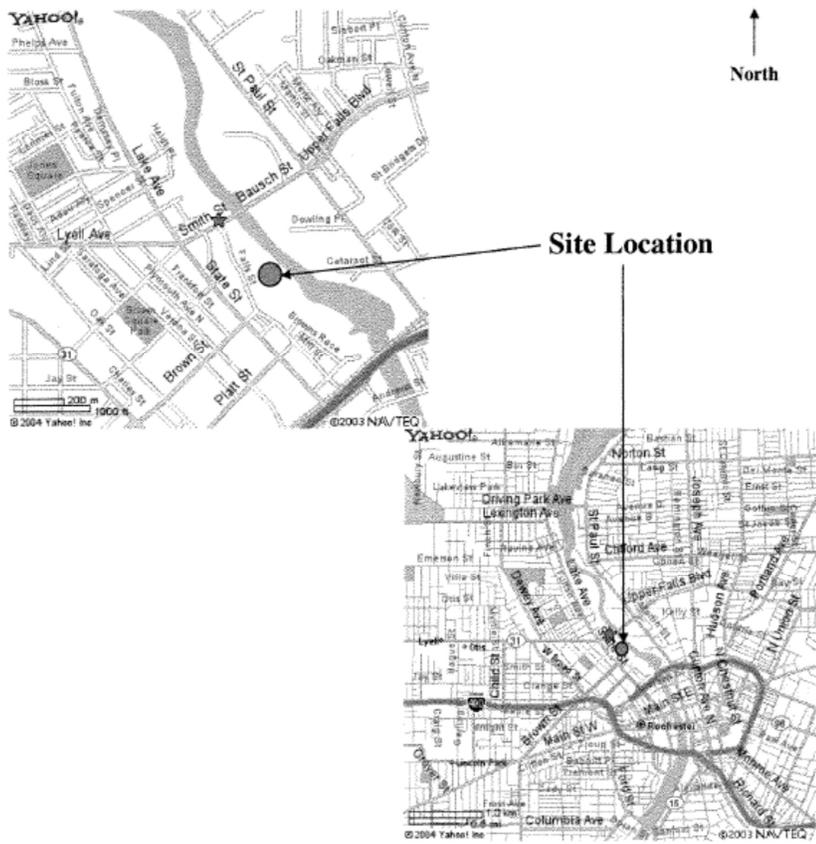
For Site-Related Health Questions, Contact:

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RG&E Contact:

Richard Marion at RG&E at
89 East Ave
Rochester, N.Y. 14649
(585) 771-4802

FIGURE 1 - Site Location





SITE LOCATION MAP
 Rochester Gas and Electric
 West Station Former MGP Plant Area RI
 Rochester, New York

By: MAC	Date: 10/2010	Project No. 12661
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AMEC Geomatrix	Figure 1
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Appendix C. Public Meeting Notes

Meeting Summary
Rochester Embayment Area of Concern (AOC) Public Meeting
Proposal to Delist Fish Deformities as a Beneficial Use Impairment Within the AOC
Tuesday, May 7, 2013
7:00 – 9:30 p.m.
Hazelwood Lodge in Ellison Park, Rochester, NY

Participants: Chris Fidler (NYSDEC), Chris Fredette (RAC), Louise Hartshorn (MCDPH), Charles Knauf (RAC/MCDPH), Gerry Pratt (NYSDEC), Paul Sawyko, (Water Education Collaborative/RAC), Jerry Sullivan (bird advocate), June Summers (Sierra Club/RAC), George Thomas (Center for Environmental Information/RAC), Steve Gibb (SCG-contractor).

Introduction and Welcome

Charles Knauf of the Monroe County Department of Public Health (MCDPH) welcomed participants, many of whom serve on the AOC's Remedial Advisory Committee (RAC) and introduced the agenda. The meeting was focused on the proposal to remove the fish tumor/deformities beneficial use impairment (BUI) within the Rochester Embayment AOC based on the latest science. The purpose of this public meeting was to receive public comment on the proposal to delist the fish tumor BUI in the AOC as a result of these surveys.

Main Presentation

Mr. Knauf cited the recent experience of the Presque Isle AOC in Erie, Pennsylvania that removed the fish deformities BUI based on the absence of liver tumors. This absence, which is now regarded by scientists as a more reliable indicator and criteria for this BUI than skin tumors, as skin lesions can have multiple physical and other causes such as viruses unrelated to environmental contamination.

Mr. Knauf introduced the topic and recent scientific investigations and noted that the BUI removal criteria is based on the absence of neoplastic or pre-neoplastic liver tumors in Bullhead Catfish, *Ameiurus nebulosus*. The formal delisting criteria were adopted directly from the International Joint Commission (IJC) language, which states that these liver tumors should be found at no "greater incidence rate within the AOC than at non-AOC control sites." There is a standardized protocol for evaluating Bullhead liver lesions, and a "reasonable rate" from surveys is expected to be approximately 2 percent in unimpacted populations. Age and gender, however, must be controlled for in comparisons as older fish have a higher prevalence of liver tumors.

In the Stage I and II Rochester AOC plans, fish tumor BUIs were listed as "unknown" because of the lack of information. A survey study was encouraged and EPA made a decision in 2007 that BUI's of unknown status should be treated as impaired. Polycyclic aromatic hydrocarbons (PAHs) are a contaminant of concern in the AOC and fish tumors were originally thought to be linked to concentrations within the Lower Genesee River and the Embayment. Gerald Pratt of the New York State Department of Environmental Conservation (NYSDEC) noted that there are four coal-tar sites within the AOC that have been releasing PAHs into local waterways. Since then, scientific investigations have cast doubt on a strong association between PAHs and liver tumors.

The original study design was to collect 50 fish from Oak Orchard Creek, which was also the reference sight for the 18 Mile Creek AOC determination and 50 from the AOC, 25 from the Genesee River, and 25 from Braddock Bay, and compare their liver tumor incidence rates. An attempt to obtain 25 bullheads from the lower Genesee River by electrofishing was unsuccessful. The contractor speculated that bullhead used the lower river mainly for spawning in the spring because the soft sediment in conjunction with rooted macrophytes preferred as foraging habitat by the fish was not present in the river except at depths too shallow to provide security to the fish. After discussion with USEPA and modification of the

QAPP, permission was received to collect an additional 25 fish from Braddock Bay. Due to the limited home range of brown bullhead, it was likely that the fish collected from Braddock Bay were resident fish in the near shore areas of the embayment portion of the REAOC and that they were a good representation of the whole AOC. Ultimately, 100 livers were reviewed by a histopathology laboratory at Cornell University and were below the “expected normal” range of 2 percent in the AOC. There were a total of 9 livers in both the AOC and 9 in non-AOC areas with any kind of lesion or disturbance, and there were no significant differences in length or age among the samples, which enhanced the comparability of the two groups. The Chi-Square statistical test showed no significant differences between the groups, and no malignant tumors were found in either location.

Mr. Knauf said that sources of PAHs in the Genesee River include oil, coal and tar deposits, byproducts of fuel burning (whether fossil fuel or biomass), and coal tar based asphalt sealers but PAH concentrations are generally well below Probable Effects Concentrations. A Combined Sewer Overflow Abatement program also prevents more than one or two sewage discharges into the river per year per discharge point, which is a significant decrease from discharge from nearly 50 release points in every rainfall event in the days before the Combined Sewage Overflow Abatement Program, and significantly reduces the impacts from stormwater runoff from impervious surfaces, many of which could contain coal tar based asphalt products.

Gerald Pratt on PAHs and Coal-Tar Sites in the AOC

Mr. Pratt is the Great Lakes AOC Coordinator for NYSDEC and the agency provides resources and technical assistance to advance cleanups and delisting AOCs. In response to a question, Mr. Pratt noted that NYSDEC was created in the 1970s and that PAHs became a concern late in that decade. He stated that the four coal-tar sites are being addressed under the state’s voluntary cleanup program, which gives companies more input over the cleanup schedule and provides benefits for their corporate social responsibility programs. Cleanups are proceeding apace and use walls and other remediation techniques to prevent offsite migration.

Ongoing AOC projects:

Gerry Pratt outlined a NYSDEC phenols monitoring effort in the AOC to support gathering information on the fish tainting and flavor BUI. A separate effort is looking at suspended sediments upstream as well to look at nutrients and suspended solids as part of the nutrients BUI. The beach algae project is poised to go ahead after the permitting process is complete this summer. AOC wetlands quality and quantity is being evaluated and a draft report will be available in August. The study will inform future habitat projects. A monitoring project is looking at nutrient levels to determine their source either within or outside the AOC. The basin has been identified as a high-priority area by NYSDEC to address nutrient and eutrophication issues, according to Mr. Pratt.

Questions:

Do you know where the NYSDEC is on issuing stream standards in terms of buffers and total maximum daily loads (TMDL)?

Gerry Pratt: That is in process now and the stream standards will form part of the TMDL. NYSDEC is under a consent order with EPA to finalize those plans and issue the TMDL.

Were you able to find enough fish in the river to make your determination?

Charles Knauf: We focused on the whole AOC, both the river and the embayment. Many fish from the bay do go up the river so we feel confident we were able to sample adequately.

Are you looking at amphibians too?

Charles Knauf: I know there is concern about this, especially with some preliminary science on malformations and pesticide exposure but the BUI is specific to fish.

The view from the north side of the ridge shows how much sediment is in Braddocks Bay. The Sierra Club representative June Summers wanted to point out the volume of sediment that flows into the AOC.

Ongoing AOC Projects Description:

Gerry Pratt noted several ongoing projects including phenols monitoring for the fish tainting BUI, which is governed by NYSDEC standards. Total suspended solids are also being monitored to see if the AOC is contributing to the eutrophication BUI.

Charles Knauf said they are in the process of implementing the Ontario Beach algae project which hinges on the permitting process with NYSDEC and USACE.

USFWS is evaluating wetlands for quantity and quality in the AOC which should be complete by August to assist with habitat restoration projects.

A USGS monitoring project at two gauging stations and “pressure points” in the watershed in the main stem is looking at nutrient levels and their sources.

Summary

Mr. Knauf summarized the presentation as follows:

- Incidence rates of fish tumors and other deformities do not exceed rates at non-AOC control sites; and
- Survey data confirm the absence of neoplastic or pre-neoplastic liver tumors in bullheads or suckers.

Endpoint: incidence rates of neoplastic tumors occurring in the AOC are no greater than incidence rates at non-AOC control sites – Haynes found no significant difference in incidence rates between all sites. Livers of bullheads from the AOC are neoplastic tumor free. The only neoplasm seen in the study came from the reference site.

Sediment data indicate declining PAH concentrations, and known sources are in management programs.

Conclusion

Although participants had questions about different topics of AOC business, there were no objections to moving forward with removing the fish tumors BUI based on the evidence presented. The public comment period will expire in early June of 2013.

Correspondence: No correspondence was received during the public comment period.

Appendix D. Responsiveness Summary

Hi Jim

Thank you for your review of the Rochester AOC delisting document for fish tumors. As a fish expert at EPA R2, your concurrence with the conclusions of this document, as well as statement of support for delisting, are very important as we go forward to delist this beneficial use impairment. Thank you for taking the time to review this document,
Barbara

-----Original Message-----

From: Kurtenbach.James <Kurtenbach.James@epamail.epa.gov>
To: Barbara Belasco <bairbrebb1@aol.com>
Sent: Tue, Nov 20, 2012 8:42 am
Subject: Re: ROCHESTER Embayment Tumor delist_final_draft_10_1.1.docx

Hi Barbara,

I reviewed the document and would concur with the findings in the document to delist based on the low incidence of liver tumors in brown bullhead. Fish from Braddock Bay are probably fairly representative of the AOC. I agree with the researchers in that the lower Genesee river is not classical habitat for a good population of brown bullheads. I base this on my fishing experience on the Genesee River and my familiarity with it. I have also extensively collected brown bullheads as part of fish surveys and have found they are generally dependent on areas of soft bottom sediment with moderate amounts of aquatic vegetation.

As a side note, please keep in mind for any future fish surveys, our division has the capability to provide these services.

If you have any additional questions I may be reached at 732-321-6695.

Jim

James Kurtenbach
Aquatic Biologist
USEPA, Region 2
Division of Environmental Science and Assessment

From: Belasco, Barbara
Sent: Monday, March 25, 2013 9:09 AM
To: Perrecone, John
Subject: Reviewer Comments on Rochester Embayment AOC Fish Tumor Report

Hi JP

[Here are Fred's reviewer comments on Rochester fish tumor delisting document.](#)
Barbara

From: Luckey, Frederick

Sent: Tuesday, January 29, 2013 12:12 PM
To: Belasco, Barbara
Cc: Reinmund-Martinez, Alicia M; Shaw, Michael; Ausubel, Seth; jagrazio@state.pa.us
Subject: Comments on Rochester Embayment AOC Fish Tumor Report

Hi Barbara,

Overall the report provides a comprehensive assessment of available information on fish tumors in the Rochester Embayment and Genesee River. I agree with the report's conclusion that the Embayment is unimpaired with respect to the fish tumor beneficial use impairment.

Below are some suggested clarifications that NYSDEC could consider that would capture some of the important fish tumor research that has been done in New York State and provide some more perspective on the degree of uncertainty around fish tumor cause effect relationships.

Section 3.B - Suggest adding the something along the lines of the following text after the first paragraph to provide additional background and context. The current discussion does not sufficiently describe the degree of uncertainty around the relationship of contaminants, in particular PAHs, to the incidence of fish liver tumors. This suggested paragraph is based on the analysis provided in the Presque Isle Bay delisting document.

Fish tumors were first thought to be caused by anthropogenic contaminants such as PAHs. Studies of brown bullheads from Lake Erie tributaries showed a strong link between PAH contaminated sediment and fish tumors (Harshbarger et al, 1984, Smith et al, 1994, Baumann & Harshbarger 1995, Pinkney et al. 2009). However studies conducted in New York State found high incidences of liver tumors in brown bullhead from relatively unpolluted lakes suggesting that factors other than contaminants may also cause fish tumors (Bowser et al, 1991, Poulet et al, 1994, Spitsbergen & Wolfe 1995). Other studies conducted in Chesapeake Bay and Lake Erie tributaries found inconsistent relationships between PAH sediment contamination and brown bull head liver tumor incidences (Baumann 2010, PADEP 2012, Pickney et al, 2011). Recent experiments exposing brown bullhead to PAH contaminated sediment did not induce liver tumors (PADEP 2012). Given these apparent contradictions it is important to carefully consider each site's unique conditions and characteristics when evaluating the status of the fish tumor and deformities BUI.

Section 3.B. Third Bullet Item -currently reads as:

· Liver neoplasms are the most consistent marker of carcinogen exposure. Research has established links between chemical contaminants and liver lesions in wild fish, and PAHs and liver cancer in fish. Viruses have not been found to cause liver cancer in fish.

Suggest breaking this bullet into three to include additional clarifications:

· Liver neoplasms are the most consistent marker of carcinogen exposure.
· Some research suggests an association between chemical contaminants and liver lesions in wild fish, and PAHs and liver cancer in fish. However other experimental work and field studies have found no correlation between PAH sediment concentrations and liver tumor incidences. These apparent contradictions suggest fish liver tumors may be caused by a multifactorial etiology that may include PAHs combined with other as yet unknown factors.

Viruses have not been found to cause liver cancer in fish.

Additional References related to suggested paragraph:

Baumann PC & Harshbarger JC 1995. Decline in liver neoplasms in wild brown bullhead catfish after coking plant closes and environmental PAHs plummet. *Environ. Health Perspect.* 103:168-70.

Bowser PR, Wolfe MJ, Reimer J, Shane B. 1991. Epizootic papillomas in brown bullheads *Ictalurus nebulosus* from Silver Stream Reservoir, New York. *Dis Aquat. Org.* 11:117-27

Harshbarger JC, Cullen LJ, Clabrese MJ, Spero PM. 1984. Epidermal, hepatocellular and cholangiocellular carcinomas in brown bullheads, *Ictalurus nebulosus*, from industrially polluted Black River, Ohio. *Mar. Environ. Res.* 14:535-6.

PADEP 2012. Presque Isle Bay Area of Concern Remedial Action Plan Stage 3 Delisting. August 2012. Pennsylvania Department of Environmental Protection. Office of Great Lakes. 301 Pennisula Drive, Suite 4, Erie, PA 16505.

Pinkney AE, Harshbarger JC, Rutter MA. 2009. Tumors in brown bullhead (*Ameiurus nebulosus*) in the Chesapeake Bay watershed: analysis of survey data - 1992 through 2006. *J. Aquatic Animal Health.* 21:71-81.

[Pinkney AE](#), [Harshbarger JC](#), [Karouna-Renier NK](#), [Jenko K](#), [Balk L](#), [Skarphéðinsdóttir H](#), [Liewenborg B](#), [Rutter MA](#). 2011. Tumor prevalence and biomarkers of genotoxicity in brown bullhead (*Ameiurus nebulosus*) in Chesapeake Bay tributaries. [Sci Total Environ.](#) 2011 Dec 1;410-411:248-57.

Poulet FM, MJ Wolfe, and JM Spitsbergen. 1994. Naturally occurring orocutaneous papillomas and carcinomas of brown bullheads (*Ictalurus nebulosus*) in New York State. *Vet. Pathol.* 31:8-18.

Smith SB, Blouin MA, Mac MJ. 1994. Ecological comparisons of Lake Erie tributaries with elevated incidence of fish tumors. *J. Great Lakes Res.* 20:701-16.

Spitsbergen JM and MJ Wolfe. 1995. The riddle of hepatic neoplasia in brown bullheads from relatively unpolluted waters in New York State. *Toxicol. Pathol.* 1995:23 716-25.

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Appendix E. Full Research Foundation Report

**BROWN BULLHEAD TUMORS AND DEFORMITIES IN THE
ROCHESTER EMBAYMENT AREA OF CONCERN**

Project Number GL 97233009-0

FINAL PROJECT REPORT

Prepared for:

USEPA Region 2
290 Broadway
New York, NY 10007

July 15, 2011

Prepared by:

James M. Haynes and Gary N. Neuderfer
Department of Environmental Science and Biology
The College at Brockport
State University of New York
350 New Campus Drive
Brockport, NY 14420

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INTRODUCTION

The 1987 amendment to the Great Lakes Water Quality Agreement authorized the U.S. and Canada to designate 42 Areas of Concern (AOC), including the Rochester Embayment of Lake Ontario, based on 14 use impairments. The Remedial Action Plan (RAP) process began in 1990, resulting in the Stage I RAP (Monroe County 1993) which identified existing conditions and data for each Beneficial Use Impairment (BUI) in the Rochester Embayment AOC, as well as whether each BUI was impaired, not impaired, or of unknown status.

The REAOC is a 35 mi² portion of Lake Ontario south of a line between Bogus Point in the town of Parma and Nine Mile Point in the town of Webster (both in Monroe County, New York), adjacent wetlands and bays, and the 6-mile reach of the Genesee River from the Lower Falls in Rochester to Lake Ontario (Figure 1; further information: <http://www.epa.gov/glnpo/aoc/rochester.html>). Land use in the watershed includes urban and suburban areas, small villages, manufacturing and industrial sites, agriculture and silviculture, and recreation.

The Rochester Embayment RAP Committee published the Stage II RAP in 1997 (Monroe County 1997), followed by delisting criteria for the majority of BUIs (Monroe County 2002). Delisting criteria were developed based on existing data and knowledge of the AOC. In December 2005, the Great Lakes Regional Collaboration Strategy to Restore and Protect the Great Lakes was published and established the goal of defining delisting criteria for all BUIs in the AOCs by the end of 2008. As part of a project for all New York AOCs undertaken by Ecology and Environment for the Niagara Falls Public Information Office of EPA, the REAOC submitted final delisting criteria to the Great Lakes National Program Office (GLNPO) in December 2008 (Ecology and Environment 2008).

Fish Tumors and Other Deformities was an impairment that needed additional investigation to determine its BUI status. In the Stage I and II RAPs, areas in the REAOC (i.e., lower Genesee River and ponds and bays along the shoreline of the Rochester Embayment) were listed as uncertain status for the BUI. The Rochester Embayment Delisting Criteria for the *Fish Tumors and Other Deformities* BUI are (Ecology & Environment 2009a):

1. Incidence rates of fish tumors or other deformities do not exceed rates at non-AOC control sites, and
2. Survey data confirm the absence of neoplastic or preneoplastic liver tumors in bullheads or suckers

This project was designed to determine the current status of the *Fish Tumors and Other Deformities* BUI in the Rochester Embayment AOC by comparing internal and external tumors

and deformities in adult brown bullhead (*Ameiurus nebulosus*) to those found in a reference area, Oak Orchard Creek (OCC), which flows into Lake Ontario ~40 miles west of the Genesee River. OCC, which is not an AOC, was the reference site for the Eighteenmile Creek (EMC) AOC BUI study on *Fish Tumors and Other Deformities* because it was recommended by the NYS Department of Environmental Conservation (NYSDEC) as a suitable control with which to compare AOC fish and wildlife survey results (Ecology & Environment 2007). OCC was also a suitable control for Rochester BUI study due to appropriate geographic proximity (same ecosystem but brown bullheads were unlikely to move between the two watersheds), similar hydrologies and habitats (drowned river mouths), and unimpeded hydrologic connections to Lake Ontario, allowing brown bullheads and other species to move freely to and from the lake.

MATERIALS AND METHODS

Using a Smith-Root 5,000-W boat electrofishing system, 100 brown bullheads were collected, 50 from previously established reference site on Oak Orchard Creek (Ecology & Environment 2009b, Figure 2) and 50 from two, roughly triangular areas of Braddock Bay in the Rochester Embayment AOC (Figure 3). Seventeen, 17 and 16 brown bullheads were collected in each of three designated reaches at the OOC reference site (Figure 2) and 25 were collected at each of the two areas in Braddock Bay (Figure 3). The initial sampling design for the Rochester Embayment was to capture 25 bullheads in Braddock Bay and 25 from the lower Genesee River; however, 6 h of electrofishing produced many fish but no bullheads in the river. With approval from USEPA Region 2, the QAPP was modified to provide for the collection of 50 bullheads in Braddock Bay. Interestingly, brown bullheads entering the lower Genesee River from Lake Ontario were common during the spawning season in the spring of 2011 (personal communication, Amanda Alexander, US Fish and Wildlife Service, Cortland, NY). Dates of collection at BB and OOC were September 4-18, 2010, and they were consistent with the mid-August to mid-September collection dates in OOC and EMC in 2007 by Ecology & Environment (2009b).

Field Examination and Processing

The field sampling procedures used for this project precisely followed Rafferty and Grazio (2006, *Field Manual for Assessing Internal and External Anomalies in Brown Bullhead*). On six dates in September 2010, brown bullheads were collected, euthanized and examined for gross external and internal body abnormalities, lesions and tumors. Adult brown bullheads ≥ 250 mm total length were kept in good health in aerated live wells until just before external and internal examination. Holding time before examination was a few hours to maintain fish in good health and minimize damage to skin from contact with other fish that might have been misinterpreted as lesions.

Immediately before examination, each fish was euthanized in a solution 250 mg of MS-222 (tricaine methane sulfonate) and 5 gal of water according to Cornell University's Fish and Amphibian

Euthanasia SOP (CARE 306.01-3.a.ii.1.a 2009). After opercular movement ceased (~5 min) a fish was considered dead. To minimize tissue changes, examination began immediately after death.

During examination each brown bullhead was measured (TL, mm), weighed (g) and photographed (whole body and suspicious marks). The external body was inspected for damaged barbels, raised skin and mouth lesions, unusual yellow and black skin pigmentation, fin erosion, ulcers, scars and wounds, abnormal eyes, and other internal irregularities. Observations were recorded on a Fish Health Data Sheet (Rafferty and Grazio 2006, p. 21). Because other abnormalities were so few, only damaged barbels, raised skin and mouth lesions, and ulcers are analyzed below.

Otoliths, pectoral fin spines and livers were removed from each fish (Rafferty and Grazio 2006, pp. 18-19). Otoliths and spines for determining age and adult status (>3 years old) were placed in labeled scale envelopes and later aged using a standard protocol (Appendix A).

Livers were excised *in toto* from each fish and placed on a wax pan. Five transverse slabs less than 1 cm thick were trimmed from each liver (Rafferty and Grazio 2006, p. 17). The slabs were placed immediately into the fish's pre-labeled container of 10% neutral buffered formalin and stored at room temperature until processed at the Cornell University Pathology Laboratory (Appendix B). Portions of any non-hepatic tissues with macroscopic abnormalities (e.g., skin, jaw and mouth lesions) also were excised (along with adjacent normal tissue) and placed in the same formalin container as the fish's liver tissue. The volume of fixative was >10 times the volume of the tissue(s).

Histo-pathological Processing and Examination

All histo-pathological procedures were performed according to Blazer et al. (2007, *Manual for the Microscopic Diagnosis of Proliferative Liver and Skin Lesions in the Brown Bullhead*) at the Cornell University Fish Pathology Laboratory. Each liver section was trimmed transversely (i.e., perpendicular to the long axis of the tissue as submitted) to provide at least one flat surface for microtoming and so that the trimmed specimen could be placed into a standard tissue cassette. The remaining liver tissues were retained in the bullhead's individual formalin container. Liver slabs and other tissues (e.g., jaw) with obvious lesions were trimmed so that a portion of the lesion and adjacent unaffected tissue would be evident in the single microtomed section from each slab. Lesions that were clearly parasitic in origin, based on macroscopic observation, were not studied further. The remaining tissue specimens were processed to paraffin-embedded sections on glass slides according to routine methods, and the slides were stained with hematoxylin and eosin before adding cover slips.

Proliferative liver lesions (foci of cellular alteration and primary liver neoplasms) were assessed according to criteria and terminology described in Blazer et al (2007), which made the data comparable to the Eighteenmile Creek study by Ecology and Environment (2009b). Each of the tissue sections on glass slides was examined via light microscope by a Fish Pathologist certified by the Fish Health Section of the American Fisheries Society who has experience in the evaluation of neoplastic fish diseases. If multiple proliferative lesions of a single type were present in one section,

they were quantified. Non-proliferative lesions were reported and scored for severity according to the following grading scheme: 1 = minimal; 2 = slight/mild; 3 = moderate; and 4 = severe. Altered foci and neoplasms were not scored for severity but were reported as "Present." Certain types of non-proliferative lesions that are not amenable to severity scoring also were reported as "Present." The pathologist attempted to correlate macroscopic observations made at necropsy or gross trimming with histo-pathologic diagnoses. Diagnoses were recorded into an electronic data system for tabulation and reporting. The histo-pathology report (Appendix B) included, but was not limited to, a narrative pathology summary (Introduction, Methods, Results, Discussion, Summary and Conclusion sections), Histo-pathology Incidence tables (HIT) and Summary Incidence tables (SIT), and Correlation of Gross and Histo-pathologic Findings tables, per Blazer et al. (2007).

The methodology outlined above is consistent with the 2007 Ecology and Environment study for the Eighteenmile Creek AOC, including using the same reference sites in Oak Orchard Creek as the control for brown bullhead samples from the Rochester Embayment AOC. Thus, results of this study are directly comparable to those in the final report for that study (Ecology and Environment 2009b).

Experimental Design and Data Analysis

Three questions were addressed in this study.

1. Are the prevalence and severity of external abnormalities in brown bullheads in the REAOC the same or different from OOC reference area?
2. Is the prevalence of proliferative liver lesions in the REAOC the same or different from OOC reference area?
3. How do the prevalence and severity of external abnormalities and prevalence of proliferative liver lesions in the REAOC in 2010 compare with the OOC reference area in 2010 and 2007 and the EMCAOC in 2007?

Kruskal-Wallis one-way non-parametric analysis of variance (excluding ties) was used to test null hypotheses that the prevalence and severity of external abnormalities (raised mouth lesions, raised skin lesions, ulcers and condition of barbels) were not significantly different among brown bullheads caught during studies at three study areas in two years: REAOC 2010, EMCAOC 2007, and OOC reference area in 2007 and 2010. Chi-square tests for heterogeneity or independence were used to test null hypotheses that there were no significant differences in the prevalence of proliferative liver lesions and liver parasites among the same brown bullheads. The Wilcoxon Rank Sum Test was used to test null hypotheses that brown bullhead collected in the Rochester Embayment AOC and the Oak Orchard Creek reference site in 2010 were the same ages, lengths and weights. The criterion for statistical significance was $\alpha=0.05$. Analyses were done with Statistix (2003).

RESULTS AND DISCUSSION

Bullhead Ages, Lengths and Weights

Animals exposed to toxic chemicals accumulate more tissue damage with increasing age; therefore, it was important that brown bullhead collected in the REAOC and OOC reference area in 2010 be equivalent in age. The average ages of brown bullhead were 9.5 ± 0.6 and 8.3 ± 0.4 years in the REAOC and OOC reference area, respectively, and were not significantly different ($P=0.231$, Table 1). No ages were reported by Ecology & Environment (2009b), so comparisons could not be made with the 2007 studies in the EMCAOC and OOC reference area.

There were no significant differences in length ($P=0.060$) and weight ($P=0.469$) of brown bullheads caught in the REAOC and OOC reference area (Table 1). Ecology & Environment (2009b) did not report length and weight data for brown bullhead in 2007 at the EMCAOC and OOC reference area but did provide length-frequency data. There were no significant differences in length frequencies ($P=0.208$, Chi-square test for heterogeneity or independence) among the four study sites (REAOC, EMCAOC, OOC reference area) in 2007 and 2010 (Figure 4). Thus, it is reasonable to assume that brown bullheads were similar in size and age in 2007 and 2010.

Prevalence and Severity of External Abnormalities among Brown Bullheads

External abnormalities recorded in the field were more prevalent in the REAOC (2010) and EMCAOC (2007) than in the OOC reference area in 2007 and 2010 but across the four sets of results 77% of the reported deformities were in the least severe category 1 (Table 2). According to Baumann and Dabrowski (2006), external aberrations should not be used to determine the status of the *Fish Tumors and Other Deformities* BUI. Perhaps this is why the results of the external abnormalities analyses from field observations are confusing. There were no significant differences in raised skin lesions ($P=0.642$) or raised mouth lesions ($P=0.070$) among locations; however, the associated Kruskal-Wallis All-Pairwise Comparisons Test suggested that the incidence of RMLs at OOC in 2007 was significantly lower than at the other locations. Differences in skin ulcers ($P=0.006$) and deformed barbels ($P=0.003$) were highly significant but the associated Kruskal-Wallis All-Pairwise Comparisons Tests indicated no differences among the summed ranks. Qualitative examination of the data suggested that the EMCAOC in 2007 had higher rates of ulcers and deformed barbels than the REAOC in 2010 and OOC in 2007 and that the OOC in 2010 had the lowest rates (Table 3).

“External tissues that were judged to be abnormal in the field were collected and submitted for microscopic evaluation. Tissues were collected and submitted from 7 fish from Braddock Bay [REAOC] and 4 fish from Oak Orchard Creek [reference area]. None of these external lesions

were interpreted as malignant neoplasms. Papillomas were diagnosed in 6 fish from Braddock Bay and in one fish from Oak Orchard Creek. Papillomas are a relatively common finding in bullheads and are hypothesized to be caused by a yet-to-be-elucidated virus. Other proliferative cutaneous lesions observed were melanomas (1 fish from Braddock Bay; 3 fish from Oak Orchard Creek) and epidermal hyperplasia (5 fish from Braddock Bay; 0 fish from Oak Orchard Creek). Relatively uncommon lesions (0 – 3 fish per study site) observed in those bullheads examined included: epidermal erosion, inflammation, abnormal tooth formation/trauma, severe infection by *Ichthyophthirius* (ciliate protozoan) and a presumptive digenean infestation (as indicated by apparent empty cysts) [Table 4 and Appendix B].

Prevalence of Proliferative Liver Lesions among Brown Bullheads

“No malignant tumors were observed during microscopic evaluation of any sectioned tissues from the brown bullheads from either collection site. The only neoplasia observed in the liver was a single adenoma, a benign tumor, in Fish OOC39 (Table 1 [Appendix B]). Other lesions observed during the microscopic evaluation of livers were found in relatively few fish (0 – 7 per site) and included clear cell foci, eosinophilic foci, basophilic foci and biliary hyperplasia. The most commonly observed lesions observed in the livers of fish from both sites were those associated with the presence of various helminth parasites (cestodes, nematodes and digeneans). The helminths or granulomas interpreted as sequelae of parasite infestation were observed in 38 fish from Braddock Bay and 39 fish from Oak Orchard Creek (Table 5 and Appendix B).”

Incidences were low (Table 5 and Appendix B) and there were no significant differences ($P=0.202$) in proliferative liver lesions in brown bullheads at the four study locations. Incidences were high (Table 5 and Appendix B) and there were highly significant differences ($P<0.0001$) in liver parasites at the four locations. This study may have reported more parasites than did Ecology & Environment (2009b) because different laboratories did the analyses and parasites were not the focus of either study.

CONCLUSIONS

1. Despite somewhat confusing statistical results, due the small number of fish with lesions at each of the four study sites in 2007 and 2010, the prevalence and severity of external abnormalities in brown bullheads did not differ between the REAOC and OOC reference area in 2010. The results suggest that the prevalence and severity of external abnormalities was higher in the EMCAOC and lower in the OOC reference area in 2010 than in either of the REAOC and OOC reference area in 2007.

2. "Comparison of representative liver sections from two sizeable study cohorts [REAOC and OOC reference area in 2010; N=50 fish each] demonstrates no significant difference in overall fish health as measured by the incidence of hepatic neoplasia (previously used as a bioindicator) [Appendix B]." There were also no significant differences in liver neoplasia results between this study and the EMCAOC and OOC reference area study in 2007 (Ecology & Environment 2009b).

RECOMMEDATION

Based on the information available, there is no reason not to delist the *Fish Tumors and Other Deformities* BUI for the Rochester Embayment of Lake Ontario.

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Table 1. Age, length and weight of brown bullheads in the Rochester Embayment Area of Concern (REAOC) and Oak Orchard Creek (OOC) reference area in 2010.

	REAOC			OOC Reference Area			
	N	Mean	SEM	N	Mean	SEM	P
Age	49	9.5	0.6	49	8.3	0.4	0.231
Length	50	332.0	4.4	50	320.9	3.7	0.060
Weight	50	450.5	18.0	50	437.5	19.7	0.469

Table 2. Field records of external deformities recorded for brown bullheads.

	Severity	REAOC 2010	OOC 2010	OOC 2007	EMCAOC 2007
Raised mouth lesions	1	6	3	1	6
	2	5	3	1	2
	3	0	1	0	1
Raised skin lesions	1	1	2	1	1
	2	0	0	0	1
	3	0	0	0	1
Ulcers	1	3	0	2	8
	2	0	0	1	1
	3	0	0	0	0
Barbels (missing, eroded or deformed)	1	11	5	6	19
	2	0	0	1	1
	3	0	1	0	0
Total external lesions		26	15	13	41
	1	21	8	10	34
	2	5	5	3	5
	3	0	2	0	2

Table 3. Incidences of external lesions and deformities in brown bullheads at four locations in two years: Rochester Embayment Area of Concern (REAOC 2010), Oak Orchard Creek reference area (OOC 2007 and 2010) and Eighteenmile Creek AOC (EMCAOC 2007). N is the number of deformities observed among 50 bullheads sampled at each location. Mean is the average severity of a deformity among 50 bullheads per location (maximum value would be 3.0 if all 50 fish had the maximum degree of deformity).

	REAOC 2010			OOC 2010			OOC 2007			EMCAOC 2007			P	Result
	N	Mean	SEM	N	Mean	SEM	N	Mean	SEM	N	Mean	SEM		
Raised Skin Lesions	1	0.02	0.02	2	0.04	0.03	1	0.02	0.02	3	0.12	0.07	0.642	NS
Raised Mouth Lesions	11	0.32	0.09	7	0.24	0.09	2	0.06	0.04	9	0.26	0.09	0.070	^a OOC07< rest
Skin Ulcers	3	0.06	0.03	0	0.00	0.00	3	0.08	0.05	9	0.20	0.06	0.006	^b EMC07>OOC07=RE10>OOC10
Deformed Barbels	11	0.22	0.06	6	0.16	0.07	7	0.16	0.06	20	0.42	0.08	0.003	^b EMC07>RE10=OOC07>OOC10
	^a Kruskal-Wallis All-Pairwise Comparisons Test suggests this result.													
	^b Kruskal-Wallis All-Pairwise Comparisons Test shows no difference among location ranks.													

Table 4. Laboratory observations of suspicious external tissues sent from the field.

	REAOC 2010	OOC 2010	OOC 2007	EMCAOC 2007
Fish with abnormalities	7	4	nd	nd
Papillomas	6	1		
Epidermal hyperplasia	5	0		
Melanoma	1	3		
Epidermal erosion	1	1		
<i>Ichthyophthirius</i> (focal, severe)	2	0		
Digenean (presumptive empty cysts)	1	0		
Abnormal tooth formation or trauma	2	3		
Inflammation	1	3		
Total abnormalities	19	11		

Table 5. Proliferative lesions and parasites in livers of brown bullheads collected in 2010 and 2007 at the Rochester Embayment and Eighteenmile Creek AOCs and the Oak Orchard Creek reference area. Fifty fish collected at each location in the years indicated.

	2010		2007	
	REAOC	OOC	OOC	EMCAOC
Altered foci	8	7	13	10
Biliary hyperplasia	4	2	0	4
Adenoma	0	1	2	2
Total liver lesions	9	9	16	15
Parasites	38	39	17	28

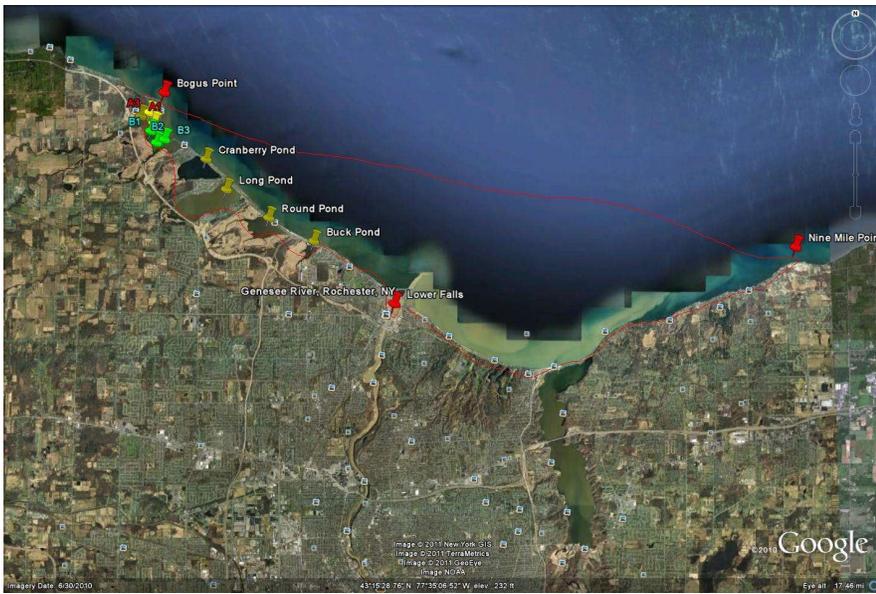


Figure 1. Rochester Embayment of Lake Ontario AOC (red line).

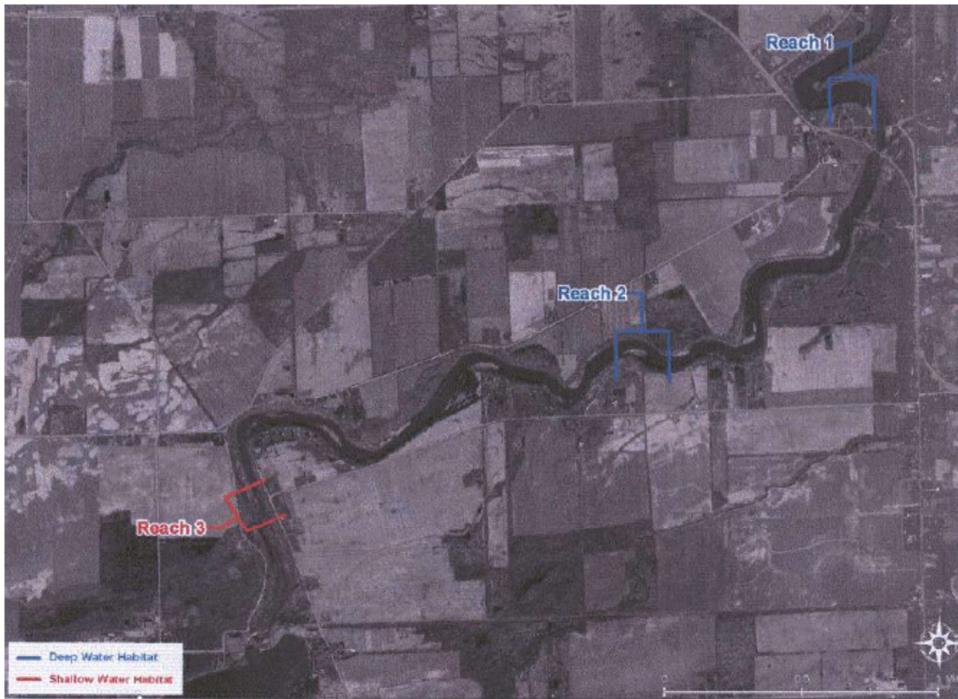


Figure 2. Oak Orchard Creek reference area, Reaches 1-3 (Ecology & Environment 2009b). (Reach 1 = 43°21' 19.00"N/ 78°11' 49.36"W → 43°21' 18.65"N/ 78°11' 35.77"W; Reach 2 = 43°20' 29.01"N/ 78°12' 30.58"W → 43°20' 31.88"N/ 78°12' 45.68"W; Reach 3 = 43°20' 07.39"N/ 78°14' 20.36"W → 43°20' 02.79"N/ 78°14' 18.56"W)

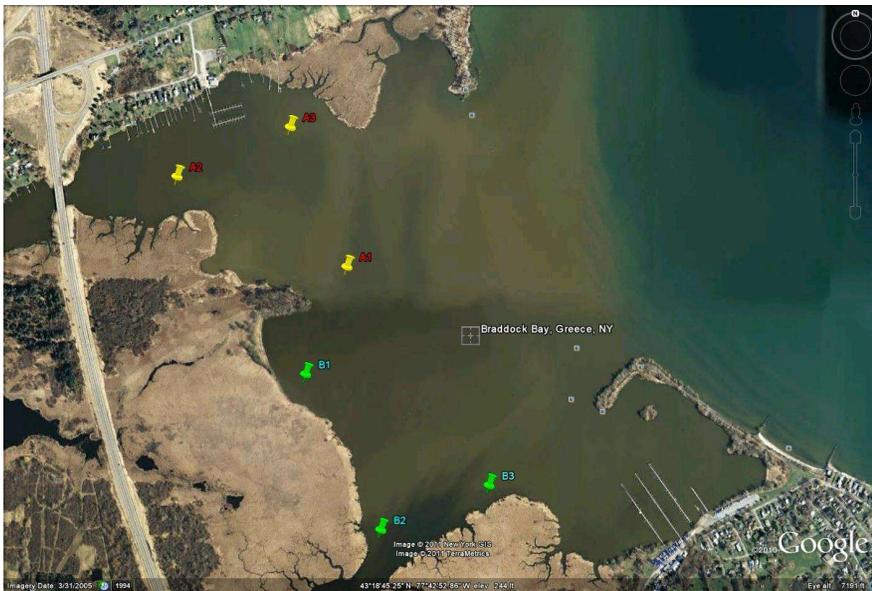


Figure 3. Rochester Embayment AOC sampling area in Braddock Bay. The GPS coordinates of corners of each triangular sampling area were A1: 43 18 47.35N/ 77 43 05.10W, A2: 43 18 55.45N/ 77 43 26.14W and A3: 43 18 59.90N/ 77 43 12.11W for Area A (yellow pins), and B1: 43 18 37.70N/ 77 43 10.21W, B2: 43 18 23.72N/ 77 43 00.90W and B3: 43 18 27.72N/ 77 43 47.49W for Area B (green pins).

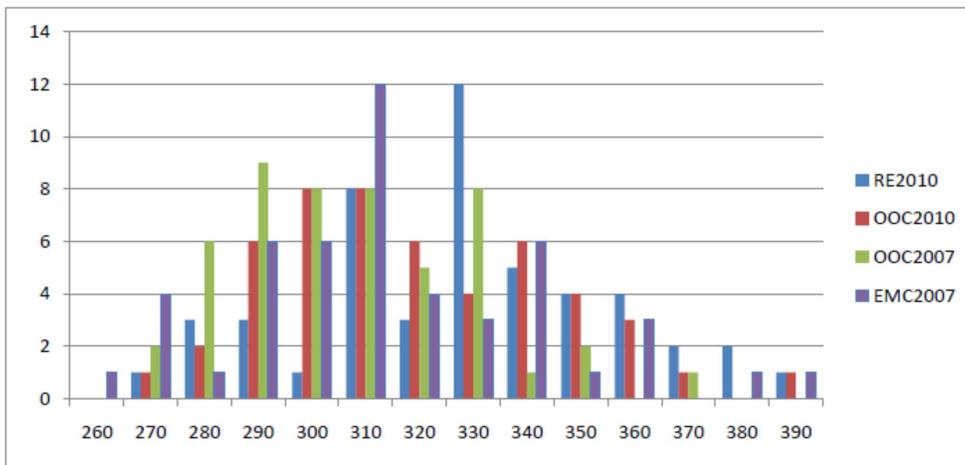


Figure 4. Length frequencies of brown bullhead in the Rochester Embayment AOC (2010), Oak Orchard Creek reference area (2007 and 2010) and Eighteenmile Creek AOC (2007).

APPENDICES

A. Protocol for Aging Brown Bullheads

- ❖ After removal otoliths are cleaned thoroughly with fresh water to remove all traces of soft tissue which upon drying can hamper processing and reading efforts.
- ❖ Otoliths are air-dried and placed in rigid storage (scintillation vials work well), no preservative is necessary or desired.
- ❖ Otoliths are examined and determination is made of the level of processing necessary for reading.
 - Smaller, more transparent otoliths may be read whole.
 - Whole mount reads will be done using light microscopy, however, a subsample of otoliths will be sectioned for ring count verification (DeVries and Frie 1996, VanderKooy and Guindon-Tisdell 2003).
 - To enhance readability of whole otoliths other techniques may be used including burning (Chilton and Beamish 1982) and dyeing (Albrechtsen 1968).
 - Otoliths that are too opaque for whole-mount reading will be sectioned using a low-speed diamond-blade saw (VanderKooy and Guindon-Tisdell 2003).
 - Otoliths to be sectioned will be attached to a glass microscope slide using Flo-texx® adhesive, following standard protocols (VanderKooy and Guindon-Tisdell 2003).
 - The otolith will first be cut in half (transverse cut) and examined to determine if more sectioning is needed for accurate reading.
 - If additional sections are needed three (3) individual transverse sections will be made, mounted flat on a new microscope slide and covered in Flo-texx® for permanent mounting.
- ❖ All otolith age determination will follow standard protocols used by National Marine Fisheries Service otolith technicians (VanderKooy and Guindon-Tisdell 2003).
 - Otoliths and otolith sections will be read using transmitted light microscopy on a compound microscope, with or without the use of stable image capture.
 - First the core of the otolith will be marked as the starting point and annual rings (annuli) will be read outward from that point.
 - The number of opaque rings will be counted from the core to the last full ring and noted as the “number of rings” on the data sheet.
 - The outer edge of the otolith will then be examined to assign a “margin code” which can be used to produce a more meaningful age estimate in partitions smaller than one year (annuli) (VanderKooy and Guindon-Tisdell 2003).

*Although otoliths from this species are quite small it is expected that annuli (growth rings) will be very obvious due to the discrete seasonality of their geographic region.

**Mr. Parnell has experience reading otoliths, scales, and spines from dozens of species of marine and freshwater fishes for demographic analyses and to provide data for NMFS management decisions. He is a certified NMFS otolith technician, has attended several annual otolith symposia, and has contributed species accounts and methods for the Gulf States Marine Fisheries Commission's "A Practical Handbook for Determining the Age of Gulf of Mexico Fishes".

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B. Histopathology Report from Cornell University

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The results presented in this report are for lesions found in Brown Bullhead (*Ameiurus nebulosus*) that were collected by a field team under the supervision of Dr. James Haynes. Samples were processed in the field; this involved gross inspection and removal of the liver from each fish, followed by fixation in 10% neutral buffered formalin in individually labeled plastic sample jars. Diagnoses were recorded into an electronic data system for tabulation and reporting. The pathology report includes a narrative pathology summary (Introduction, Methods, Results, Discussion, Summary and Conclusion Sections); Histopathology Incidence Tables (Table 1. HIT) and Summary Incidence Tables (Table 2. SIT); and Correlation of Gross and Histopathologic Findings Tables (Table 3) (Blazer et al. 2007).

In preparation for histopathologic examination the livers of brown bullheads were excised in toto from each fish and laid on a cutting surface. Five transverse slabs less than 1 cm thick were trimmed from each liver (see Figure 7-3 from Rafferty and Grazio 2006). The slabs were to be located approximately equidistant from one another, except that one or more of the slabs may be oriented to include any macroscopic liver lesion(s) that might be present. The slabs were placed immediately into the fish's labeled individual container of 10% neutral buffered formalin in a 10:1 ratio of formalin to tissue. Portions of any non-hepatic tissues with macroscopic abnormalities (those amenable to sampling) were placed in the same formalin container. These "other" tissue specimens were likewise trimmed so that they were no wider than 1 cm in at least one dimension and contained adjacent normal tissue, if possible. Such specimens could be placed into labeled tissue cassettes to facilitate subsequent identification. No other tissues were to be collected routinely unless specified by protocol amendment. Sections from these "other" tissues may be included by Dr. Bower's lab on liver tissue slides, and are included in the budget for this project. If necessary, these other tissues could be processed under a future project. All sample containers, tissue cassettes, and microscope slides were stored at room temperature until processed.

All histopathological procedures were performed according to Blazer et al. (2007), „Manual for the Microscopic Diagnosis of Proliferative Liver and Skin Lesions in the Brown Bullhead (*Ameiurus nebulosus*)". The formalin fixed tissues were processed at the Aquatic Animal Health Laboratory, Cornell University under the supervision of Dr. P. R. Bowser. Each of the liver

sections was trimmed transversely (i.e. perpendicular to the long axis of the tissue as submitted) to provide at least one flat surface for microtoming and so that the trimmed specimen could be placed into a standard tissue cassette. The remaining liver tissues were retained in the animal's individual formalin container. Liver slabs with obvious lesions were trimmed so that a portion of the lesion(s) and, if possible, a portion of adjacent unaffected tissue, would be evident in the single microtomed section to be produced from each slab. Excluded from this requirement are lesions that are clearly parasitic in origin based on macroscopic observation.

Specimens in cassettes were processed to paraffin-embedded sections on glass slides according to routine methods, and stained with hematoxylin and eosin prior to cover-slipping. Non-hepatic tissues were retained in the animal's individual formalin container and only processed to slides if specified by protocol amendment. They may be used for a future project, and will be retained by The College at Brockport.

Each of the sections on glass slides were examined via light microscopy by the following individuals:

Dr. Paul R. Bowser, Professor of Aquatic Animal Medicine
Aquatic Animal Health Program, Department of Microbiology and Immunology
College of Veterinary Medicine, Cornell University, Ithaca, New York 14853-6401
Dr. Bowser has over 30 years of experience as a faculty member at three major research institutions (University of California at Davis, Mississippi State University, Cornell University) as an aquatic animal health specialist. He is certified as a Fish Pathologist by the Fish Health Section of the American Fisheries Society and is widely known for his expertise in fish pathology.

Dr. Hannah Bender, Resident in Pathology, Section of Anatomic Pathology
Department of Biomedical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, New York 14853-6401
Dr. Bender is a Veterinarian who is currently in the Residency Program in Anatomic Pathology at the College of Veterinary Medicine at Cornell University. She has particular interest in diseases of zoo, wildlife and aquatic animal species.

Consultation for certain cases was sought from:

Dr. Teresa Southard, Assistant Professor of Pathology Department of Biomedical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, New York 14853-6401
Dr. Southard is a diplomate of the American College of Veterinary Pathologists and a faculty member in the Section Anatomic Pathology, Department of Biomedical Sciences at the College of Veterinary Medicine at Cornell University. She has particular interest and expertise in laboratory animal pathology.

All slides were evaluated independently by Dr. Bowser and Dr. Bender. In the case of certain slides, consultation was sought from Dr. Southard. A consensus diagnosis was reached and is presented in this report.

Proliferative liver lesions (foci of cellular alteration and primary liver neoplasms) were assessed according to criteria and terminology described in Blazer et al. (2007). By using established methods in this study, the current data set is comparable to the Eighteenmile Creek study (Ecology and Environment 2009). If multiple proliferative lesions of a single type were present in one section, these were quantified. However, in such instances the term “multiple” will be a component of the diagnosis. In general, non-proliferative lesions were reported and scored for severity according to the following grading scheme: 1 = minimal; 2 = slight/mild; 3 = moderate; and 4 = severe. Altered foci and neoplasms were not scored for severity; and instead were reported as “Present”. Certain types of non-proliferative lesions that are not amenable to severity scoring were also being reported as “Present”. Where possible, macroscopic observations made at necropsy or during trimming were correlated with histopathologic diagnoses.

No malignant tumors were observed during microscopic evaluation of any sectioned tissues from the brown bullheads from either collection site. The only neoplasia observed in the liver was a single adenoma, a benign tumor, in Fish OOC39 (Table 1). Other lesions observed during the microscopic evaluation of livers were found in relatively few fish (0 – 7 per site) and included clear cell foci, eosinophilic foci, basophilic foci and biliary hyperplasia. The most commonly observed lesions observed in the livers of fish from both sites were those associated with the presence of various helminth parasites (cestodes, nematodes and digeneans). The helminths or granulomas interpreted as sequelae of parasite infestation were observed in 38 fish from Braddock Bay and 39 fish from Oak Orchard Creek.

External tissues that were judged to be abnormal in the field were collected and submitted for microscopic evaluation. Tissues were collected and submitted from 7 fish from Braddock Bay and 4 fish from Oak Orchard Creek. None of these external lesions were interpreted as malignant neoplasms. Papillomas were diagnosed in 6 fish from Braddock Bay and on one fish from Oak Orchard Creek. Papillomas are a relatively common finding in bullheads and are hypothesized to be caused by a yet-to-be-elucidated virus. Other proliferative cutaneous lesions observed were melanomas (1 fish from Braddock Bay; 3 fish from Oak Orchard Creek) and epidermal hyperplasia (5 fish from Braddock Bay; 0 fish from Oak Orchard Creek). Relatively uncommon lesions (0 – 3 fish per study site) observed in those bullheads examined included: epidermal erosion, inflammation, abnormal tooth formation/trauma, severe infection by *Ichthyophthirius* (ciliate protozoan) and a presumptive digenean infestation (as indicated by apparent empty cysts).

Comparison of representative liver sections from two sizeable study cohorts demonstrates no significant difference in overall fish health as measured by the incidence of hepatic neoplasia (previously used as a bioindicator). Additional cutaneous lesions were considered incidental findings, as were the metazoan parasite and associated hepatic granulomas.

LITERATURE CITED

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Ecology and Environment. 2009. Beneficial Use Impairment Investigation for Eighteen mile Creek, Niagara County, New York. Report Number 002386_NC13_02-B2423, Ecology and Environment, Lancaster, NY.

Rafferty, S. and J. Grazio. 2006. Field Manual for Assessing Internal and External Anomalies in Brown Bullhead (*Ameiurus nebulosus*). Pennsylvania Sea Grant. 23 pp. <http://seagrant.psu.edu/publications/technicaldocs/BullheadFieldManual.pdf>.

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (page 1 of 10)

BB01	BB02	BB03	BB04	BB05	BB06	BB07	BB08	BB09	BB10
LIVER			NSF				NSF		
Clear cell focus									
Eosinophilic focus					n = 1				
Basophilic focus									
Biliary hyperplasia									
Adenoma									
Parasites (helminthes and granulomas)	multiple	multiple	multiple	multiple	multiple	multiple	multiple	multiple	few
EXTERNAL									
Describe					Papilloma, epidermal hyperplasia				

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 2 of 10)

BB11	BB12	BB13	BB14	BB15	BB16	BB17	BB18	BB19	BB20
LIVER			NSF				NSF		
Clear cell focus					n = 2				
Eosinophilic focus									
Basophilic focus									
Biliary hyperplasia			present				present		
Adenoma									
Parasites (helminthes and granulomas)	few	few	multiple						
EXTERNAL									
Describe									

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 3 of 10)

BB21	BB22	BB23	BB24	BB25	BB26	BB27	BB28	BB29	BB30
LIVER			NSF			NSF			
Clear cell focus									
Eosinophilic focus			n = 1			n = 1			
Basophilic focus									
Biliary hyperplasia			present			present			
Adenoma									
Parasites (helminthes and granulomas)	multiple	multiple	multiple	few	multiple	multiple	multiple	multiple	multiple
EXTERNAL									
Describe					Epidermal hyperplasia, papilloma, severe focal <i>Ichthyophthirius</i>				

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 4 of 10)

BB031	BB032	BB033	BB034	BB035	BB036	BB037	BB038	BB039	BB40
LIVER		NSF		NSF		NSF		NSF	
Clear cell focus									
Eosinophilic focus					n = 1				
Basophilic focus					n = 1				
Biliary hyperplasia									
Adenoma									
Parasites (helminthes and granulomas)	few	few	multiple	multiple	multiple	multiple	multiple	multiple	multiple
EXTERNAL									
Describe					Epidermal hyperplasia, papilloma, Digenean (presumptive, 2 cysts)				

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 5 of 10)

BB41	BB42	BB43	BB44	BB45	BB46	BB47	BB48	BB49	BB50	
LIVER										
Clear cell focus										
Eosinophilic focus			n = 2				n = 1			
Basophilic focus										
Biliary hyperplasia										
Adenoma										
Parasites (helminths and granulomas)	few	multiple	multiple	multiple	multiple	few	few	multiple	multiple	multiple
EXTERNAL										
Describe	Epidermal hyperplasia, papilloma			Epidermal hyperplasia, papilloma, melanoma, severe focal <i>Ichthyophthirius</i>			Papilloma	Epidermal erosion		

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 6 of 10)

OOC01	OOC02	OOC03	OOC04	OOC05	OOC06	OOC07	OOC08	OOC09	OOC10	
LIVER										
Clear cell focus										
Eosinophilic focus					n = 1					
Basophilic focus										
Biliary hyperplasia										
Adenoma										
Parasites (helminthes and granulomas)	few	multiple	few	few	few	multiple	few	multiple	multiple	few
EXTERNAL										
Describe			Inflammation, melanoma, abnormal tooth formation/ trauma ?				Inflammation, melanoma, abnormal tooth formation/ trauma ?			

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 7 of 10)

OOC11	OOC12	OOC13	OOC14	OOC15	OOC16	OOC17	OOC18	OOC19	OOC20
LIVER									
Clear cell focus				NSF			NSF		
Eosinophilic focus			n = 1			n = 1			
Basophilic focus									
Biliary hyperplasia					present				
Adenoma									
Parasites (helminthes and granulomas)	multiple	few	few	multiple	multiple	few	multiple	multiple	
EXTERNAL									
Describe									

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 8 of 10)

OOC21	OOC22	OOC23	OOC24	OOC25	OOC26	OOC27	OOC28	OOC29	OOC30
LIVER					NSF				
Clear cell focus									
Eosinophilic focus			n = 1			n = 1			
Basophilic focus									
Biliary hyperplasia					present				
Adenoma									
Parasites (helminthes and granulomas)	few	few	multiple	multiple	few	multiple	multiple	few	few
EXTERNAL									
Describe									

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 9 of 10)

OOC31	OOC32	OOC33	OOC34	OOC35	OOC36	OOC37	OOC38	OOC39	OOC40
LIVER		NSF		NSF		NSF		NSF	
Clear cell focus									
Eosinophilic focus					n = 1				
Basophilic focus									
Biliary hyperplasia									
Adenoma					present				
Parasites (helminthes and granulomas)	few	multiple	few	present	few	few	multiple		
EXTERNAL									
Describe					Inflammation, melanoma, abnormal tooth formation/ trauma ?				

Table 1. HISTOPATHOLOGY INCIDENCE TABLE (cont. page 10 of 10)

OOC41	OOC42	OOC43	OOC44	OOC45	OOC46	OOC47	OOC48	OOC49	OOC50
LIVER					NSF				
Clear cell focus									
Eosinophilic focus					n = 3				
Basophilic focus									
Biliary hyperplasia									
Adenoma									
Parasites (helminthes and granulomas)	few	multiple	multiple	multiple	few	multiple	few	few	few
EXTERNAL									
Describe					Papilloma, epidermal erosion, inflammation				

Table 2. SUMMARY INCIDENCE TABLE

	Braddock Bay	Oak Orchard Creek
Liver (Number examined)	50	50
Clear Cell focus	1	0
Eosinophilic focus	6	7
Basophilic focus	1	0
Biliary hyperplasia	4	2
Adenoma	0	1
Parasites (helminths or granulomas from helminthes)	38	39
External abnormalities (Number examined)	7	4
Papillomas	6	1
Epidermal hyperplasia	5	0
Melanoma	1	3
Epidermal erosion	1	1
<i>Ichthyophthirius</i> (focal, severe)	2	0
Digenean (presumptive empty cysts)	1	0
Abnormal tooth formation/ trauma?	2	3
Inflammation	1	3

Table 3. CORRELATION OF GROSS AND MICROSCOPIC FINDINGS (page 1 of 2)

Animal Number	Organ/Tissue	Client Gross Observations	Microscopic Observations
BB01 – BB50	Liver	None	During trimming no grossly abnormal areas were observed; subsequent microscopic observations indicate that the lesions were too small to be observed by the unaided eye.
OOC01 – OOC50	Liver	None	During trimming no grossly abnormal areas were observed; subsequent microscopic observations indicate that the lesions were too small to be observed by the unaided eye.
BB06	Skin	Skin lesions: top of head, right side near dorsal fin	Gross appearance of epidermal hyperplasia during tissue trimming was consistent with microscopic findings.
BB28	Upper and lower jaw	Lesions: upper/lower jaw tooth pads, tongue	Gross appearance of lesion during tissue trimming was consistent with microscopic findings. Severe focal <i>Ichthyophthirius</i> was only found upon microscopic evaluation.
BB36	Skin behind tooth pads	Black spots: skin behind upper/lower tooth pads	Gross appearance of lesion during tissue trimming was consistent with microscopic findings. Presence of two presumptive digenean cysts was detected only upon microscopic evaluation.
BB42	Tooth pads	Lesions: upper/lower jaw tooth pads	Gross appearance of lesion during tissue trimming was consistent with microscopic findings.
BB48	Skin on caudal peduncle	Lesions: lower jaw, caudal peduncle skin	Gross appearance of lesion during tissue trimming was consistent with microscopic findings. Severe focal <i>Ichthyophthirius</i> was only found upon microscopic evaluation.
BB49	Upper and lower jaws	Lesions: upper/lower jaws	Gross appearance of papilloma during tissue trimming was consistent with microscopic findings.
BB50	tongue	Lesion: tongue	Gross appearance of papilloma during tissue trimming was consistent with microscopic findings.
OOC08	Lower jaw	Lesion: lower left jaw	A lesion was observed upon trimming of the tissue, but the presence of epidermal erosion was only determined upon microscopic evaluation.
OOC09	Lower jaw and pectoral fin	Lesions: lower jaw, right pectoral fin	A lesion was observed upon trimming of the tissue, but the specific nature of the lesion was only determined upon microscopic evaluation.

Table 3. CORRELATION OF GROSS AND MICROSCOPIC FINDINGS (page 2 of 2)

Animal Number	Organ/Tissue	Client Gross Observations	Microscopic Observations
OOC36	Upper and lower jaw	Lesions: upper/lower jaws-right side	A lesion was observed upon trimming of the tissue, but the specific nature of the lesion was only determined upon microscopic evaluation.
OOC49	Interior of mouth	Lesions: top/bottom of mouth-left side	Gross appearance of lesion during tissue trimming was consistent with microscopic findings.