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LAKE UNION FISH HISTOPATHOLOGY STUDY

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INTRODUCTION

The links between biological abnormalities and contaminant exposure in fish has been studied intensively in marine waters of Puget Sound (Malins *et al.*, 1982). However, these possible links have rarely been studied in freshwater environments of Washington State. Landolt and Kocan (1987) reviewed studies of contaminants in other freshwater regions in the United States where pathological conditions have been found in fish. In areas of high aromatic hydrocarbon contamination, Bauman *et al.* (1982) found hepatic neoplasms in brown bullheads (*Ictalurus nebulosus*) in Ohio's Black River. Black (1983) induced hepatocellular and oral carcinomas in brown bullheads by painting fish with sediment collected from the Buffalo River in New York, which contained high concentrations of aromatic hydrocarbons.

Gasworks Park, a 20 acre park on the north shore of Lake Union, Seattle, Washington, is the site of a retired coal gasification plant that ran for 50 years ending in 1956. The sediments adjacent to Gasworks Park are heavily contaminated with a number of toxic compounds including polycyclic aromatic hydrocarbons (PAH), heavy metals, and cyanide (Hileman *et al.*, 1985; Yake *et al.*, 1985). Fish residing in this urban lake may be exposed to relatively high concentrations of PAH and heavy metals. To determine if fish exposed to these contaminants show abnormalities, liver, kidney and gills from 157 fish were examined with histopathology methods. Blood was also examined.

METHODS

Specimen Collection

A total of 188 fish were collected from Lake Union over two sampling periods. Seventy-three (73) fish were sampled during the first period (June 10-11, 1990); one hundred fifteen (115) were sampled during the second period (September 10-11, 1990). Figure 1 shows the study site. Table 1 reviews species composition by site. Scientific names of fishes are presented in Appendix 1. Fish were caught in June with two fyke nets, one at Gasworks Park and one at Navy Cove. In September the fyke nets were supplemented with a shocking boat operating in the evening at Gasworks Park, Nancy Cove and Portage Bay. All fish were captured live, placed in live tanks or buckets on board the sampling boat, then transferred to shore live in buckets for examination.

Examination

External

A blood sample was obtained from each fish using either caudal vein puncture or severance of the caudal peduncle (depending upon size of the specimen). The fish was then sacrificed by a blow to the head, taxonomically identified, assigned an accession number, measured (total length in mm), weighed (grams), and examined for the presence of externally visible lesions. Mean lengths and weights are summarized in Tables 2 and 3. External lesions are listed in Appendix 2.

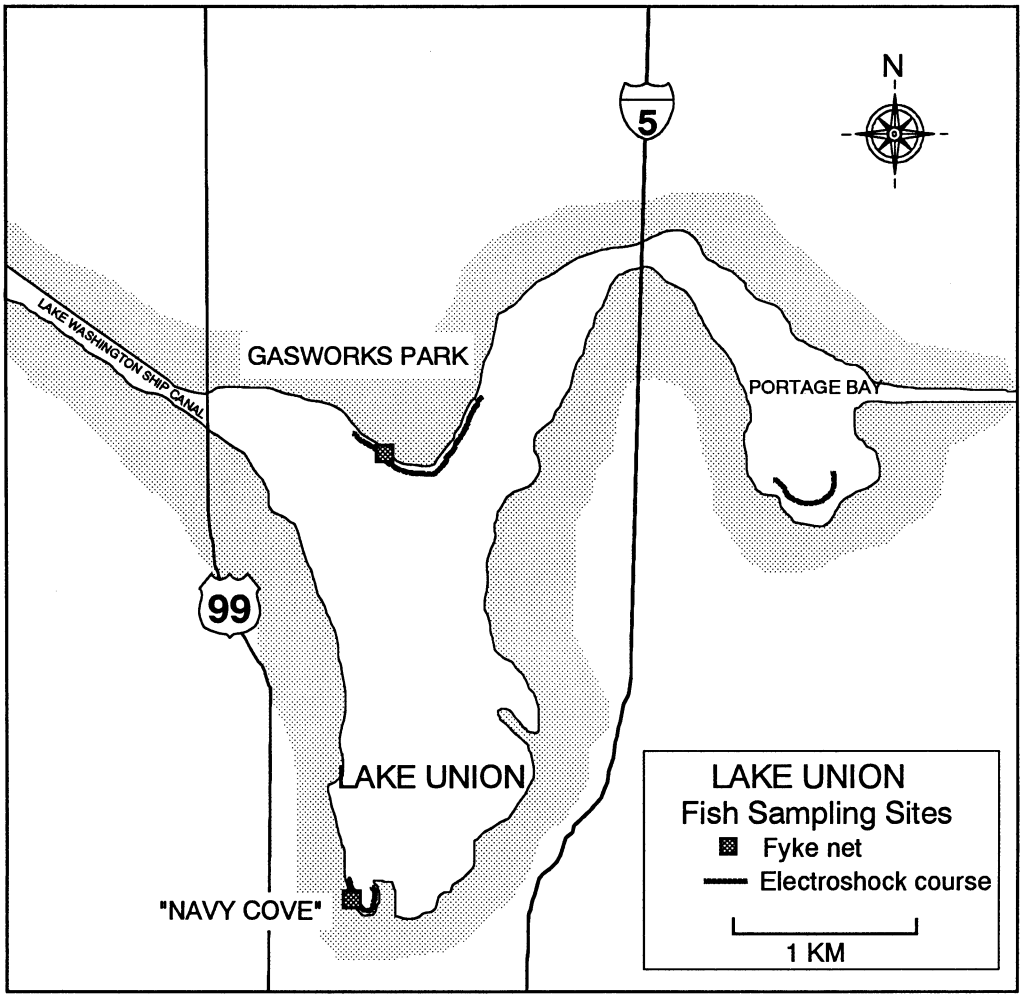

Figure 1. Study site showing location of fish collection

Table 1. Species taken from each collection site during two sampling periods.

Species	Gasworks Park	Navy Cove	Portage Bay
First Collection Period (June 10-11, 1990)			
Yellow Perch	6	7	0
Three Spine Stickleback	33	15	0
Pumpkinseed	1	5	0
Sculpin	1	5	0
Squawfish	0	0	0
Large Scale Sucker	0	0	0
Largemouth Bass	0	0	0
Smallmouth Bass	0	0	0
White Crappie	0	0	0
Rainbow Trout	0	0	0
Peamouth Chub	0	0	0
Bluegill Sunfish	0	0	0
Brown Bullhead	0	0	0
Starry Flounder	0	0	0
Second Collection Period (September 10-11, 1990)			
Yellow Perch	38	10	4
Three Spine Stickleback	0	0	0
Pumpkinseed	20	4	4
Sculpin	3	0	0
Squawfish	1	3	0
Large Scale Sucker	3	0	1
Largemouth Bass	5	0	2
Smallmouth Bass	2	0	0
White Crappie	2	0	1
Rainbow Trout	5	0	0
Peamouth Chub	2	0	0
Bluegill Sunfish	2	0	0
Brown Bullhead	2	0	0
Starry Flounder	1	0	0

Table 2. Mean length (mm) of fish taken from each collection site during two sampling periods.

Species	Gasworks Park	Navy Cove	Portage Bay
First Collection Period (June 10-11, 1990)			
Yellow Perch	188.2	227.3	--*
Three Spine Stickleback	75.8	69.9	--
Pumpkinseed	137.0	88.6	--
Sculpin	137.0	119.4	--
Squawfish	--	--	--
Large Scale Sucker	--	--	--
Largemouth Bass	--	--	--
Smallmouth Bass	--	--	--
White Crappie	--	--	--
Rainbow Trout	--	--	--
Peamouth Chub	--	--	--
Bluegill Sunfish	--	--	--
Brown Bullhead	--	--	--
Starry Flounder	--	--	--
Second Collection Period (September 10-11, 1990)			
Yellow Perch	164.2	167.9	162.0
Three Spine Stickleback	--	--	--
Pumpkinseed	130.5	122.2	129.0
Sculpin	108.7	--	--
Squawfish	216.0	225.3	--
Large Scale Sucker	264.0	--	364.0
Largemouth Bass	192.2	--	101.0
Smallmouth Bass	216.0	--	--
White Crappie	164.5	--	170.0
Rainbow Trout	253.2	--	--
Peamouth Chub	225.0	--	--
Bluegill Sunfish	105.5	--	--
Brown Bullhead	286.0	--	--
Starry Flounder	149.0	--	--

* -- indicates that no fish were collected

Table 3. Mean weight (g) of fish taken from each collection site during two sampling periods.

Species	Gasworks Park	Navy Cove	Portage Bay
First Collection Period (June 10-11, 1990)			
Yellow Perch	84.2	167.8	--*
Three Spine Stickleback	5.6	4.5	--
Pumpkinseed	62.5	19.7	--
Sculpin	30.6	21.8	--
Squawfish	--	--	--
Large Scale Sucker	--	--	--
Largemouth Bass	--	--	--
Smallmouth Bass	--	--	--
White Crappie	--	--	--
Rainbow Trout	--	--	--
Peamouth Chub	--	--	--
Bluegill Sunfish	--	--	--
Brown Bullhead	--	--	--
Starry Flounder	--	--	--
Second Collection Period (September 10-11, 1990)			
Yellow Perch	59.1	63.9	46.2
Three Spine Stickleback	--	--	--
Pumpkinseed	53.2	42.7	47.0
Sculpin	11.7	--	--
Squawfish	79.0	103.3	--
Large Scale Sucker	200.0	--	560.0
Largemouth Bass	127.4	--	9.5
Smallmouth Bass	167.5	--	--
White Crappie	62.0	--	72.0
Rainbow Trout	130.4	--	--
Peamouth Chub	98.0	--	--
Bluegill Sunfish	24.5	--	--
Brown Bullhead	310.5	--	--
Starry Flounder	35.0	--	--

* -- indicates that no fish were collected

Internal

The body cavity was opened and the internal organs were inspected for the presence of visible defects. Representative tissue samples were collected from each of the following organs: liver, kidney, gill. Tissues were preserved in Bouin's fixative.

Histopathology

Preserved tissues from 157 fish were prepared for light microscopy. Tissues were dehydrated through a graded ethanol series, cleared with xylene, embedded in paraffin, sectioned at 5 um and stained with hematoxylin and eosin dyes. Stained sections of liver, kidney, and gill tissue were examined by Busch. Each organ was first scanned at low magnification (40X) for general form and contour. Subsequently, the entire section was examined at high magnification (430X) for the presence of pathological alterations. A verbal description of each lesion was recorded on the data sheet and the severity of the change was indicated by a numerical score ranging from mild (severity score = 1), to moderate (severity score = 2), to severe (severity score = 3). Because the terminology used in verbal descriptions frequently varies from one pathologist to another, a numerical code was assigned to each lesion. The codes were derived from the National Ocean Data Center's (NODC) histopathology coding system, and were displayed on the datasheet as hyphenated numbers containing two descriptors. The first number indicated the suborgan, the second number indicated the specific lesion. For example, code 12-116 indicates that helminth parasites (116) were present on the serosa (12) of the liver. The histopathological data are compiled in Appendix 2. Histopathological terms may be found in Appendix 3.

Hematology

Blood films were prepared, air dried, preserved with methanol and stained with Giemsa dye. Blood smears were evaluated by Busch. A review of hematological terms may be found in Appendix 3. NODC codes are not available for hematological terms; thus, they were not used in the data summary (Appendix 2).

Gonad

Gonadal tissue was examined in order to identify the sex of the fish. The tissue was not evaluated for the presence of lesions.

RESULTS

All examination results are reviewed in Appendix 2.

Liver

The majority of the lesions noted were conditions that could be attributed to parasitism (e.g. free parasites, encapsulated parasites, parasitic granulomas, parasitic serositis) or conditions that represent non-specific response to injury (e.g. necrosis, mononuclear cell infiltrates). No

neoplasms or signs of severe toxicity were noted. Two possible preneoplasms were observed. An area of focal change similar to an eosinophilic nodule was found in a yellow perch collected near Gasworks Park; an area of focal change similar to a clear cell focus was found in a yellow perch collected in Navy Cove.

Nuclear pleomorphism and non-uniform vacuolation, changes frequently associated with chronic exposure to contaminants, were prominent in sculpins. It is possible that this species is uniquely sensitive to contaminant exposure or that some feature of their life style increases their exposure.

Kidney

Few lesions were noted in the kidney. The most common lesions were changes associated with parasitism (e.g. free parasites, parasitic granulomas). Other changes included focal inflammation, deposition of pigment in glomerular tissue, and vacuolation of tubular epithelium. No neoplasms, preneoplasms, or signs of profound toxicity were observed.

Gills

With the exception of the presence of parasites on the surface of the lamellae, relatively few lesions were noted in the gill tissue. Microaneurysms and epithelial cell hyperplasia were observed with some frequency. These conditions may result from a variety of infectious and non-infectious disease processes.

Blood

Serious hematological changes were not observed. Most of the alterations noted (e.g. bacteremia, activated macrophages, leucocytosis, leucopenia) are changes that may accompany bacterial infection. There was no evidence of neoplastic disorder or severe dyscrasias.

CONCLUSIONS AND RECOMMENDATIONS

This study represented the first attempt by the Department of Ecology to evaluate the health of fish in Lake Union. As a consequence, this project was more a feasibility study than a systematic survey. Goals of the project were to compare the utility of different types of sampling gear, to determine the species of fish that might reasonably be obtained, and to examine the health of as many species as possible in order to identify target species candidates.

If further work is to be conducted in Lake Union, the following recommendations are made.

1. Focus collection efforts on sculpins and brown bullheads. Sculpins, because of their biological characteristics, their tendency to be non-migratory, and the lesions observed in the present study, appear to be a good target species. If it is possible to target two species, bullheads would be a good second choice due to their benthic habitat and histopathological responses observed during studies of this species in other areas with the same classes of pollutants present.

2. Focus collection efforts on obtaining adequate (60 fish per site) numbers of one or two target species, rather than low numbers of many species.

3. Identify a reference site and compare the prevalence of lesions at that site with the prevalence at various stations within Lake Union.

4. In the absence of grossly visible lesions in other organs, collect only liver tissue for histopathological evaluation.

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APPENDICES

Appendix 1. Scientific names of fish caught in histopathology study.

Common Name	Latin name
Yellow perch	*Perca flavenscens*
Three spine stickleback	*Gasterosteus aculeatus*
Pumpkinseed	*Lepomis gibbosus*
Sculpin	*Cottus sp.*
Squawfish	*Ptychocheilus oregonensis*
Largescale sucker	*Catosomus macrocheilus*
Largemouth bass	*Micropterus salmoides*
Smallmouth bass	*Micropterus dolomieui*
White crappie	*Pomoxis annularis*
Rainbow trout	*Salmo gardneri*
Peamouth chub	*Mylocheilus caurinus*
Bluegill sunfish	*Lepomis macrochirus*
Brown bullhead	*Ictalurus nebulosus*
Starry flounder	*Platichthys stellatus*

Appendix 2. Catalog of all fish collected and examined.

NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
LU-8	Gasworks	Stickleback	Focal Necrosis	1	14-308	Sporozoa	2	351-58	Trichodinids	1	314-34	Rosette-Rbc
			Granulomas	2	73-219				Interlam. Parasite	1	314-185	Regen Anemia
			Vacuolation	3	14-482							
LU-9	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	NVL
LU-10	Gasworks	Stickleback	Multiloc. Struc.	?	?	Sporozoa	2	351-58	NVL		0-01	NVL
			Focal Necrosis	2	14-308							
			Mitotic Figures	1	14-529							
LU-11	Gasworks	Stickleback	Non Uni Vacuol	2	14-483	NVL		0-01	Aneurysms	1	314-907	NVL
LU-12	Gasworks	Stickleback	Non Uni Vacuol	3	14-483	Sporozoa	1	351-58	Monogenetic Trem	1	314-100	Vac Macro
			Nuclear Pleo	2	14-406							Bacteremia
			Focal Necrosis	2	14-308							Karyol-Wbc
LU-13	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Monogenetic Trem	1	314-100	Bacteremia
												Aniso-Rbc
LU-14	Gasworks	Stickleback	NVL		0-01	Glomer Pig	1	301-363	NVL		0-01	NVL
LU-15	Gasworks	Stickleback	NVL		0-01	Glomer Pig	1	301-363	Trichodinids	2	314-34	NVL
									Lamel Hyperplasia	1	314-707	
LU-16	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Trichodinids	1	314-34	Aniso-Rbc
LU-17	Gasworks	Stickleback	Focal Necrosis	2	14-308	NVL		0-01	Aneurysms	1	314-907	NVL
			Coccidia	3	14-58							
LU-18	Gasworks	Stickleback	Non Uni Vacuol	2	14-483	NVL		0-01	NVL		0-01	Aniso-Rbc
			Nuc Pleo	2	14-406							Leucopenia
			Focal Necrosis	1	14-308							
LU-19	Gasworks	Stickleback	Necrosis	2	14-308	Sporozoa	2	351-58	Trichodinids	1	314-34	NVL
						Glomer Pig	1	301-363				
LU-20	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	Leucopenia
LU-21	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	Leucopenia
LU-22	Gasworks	Stickleback	Mononuc Infil	1	14-234	Sporozoa	1	351-58	NVL		0-01	Leucopenia
LU-23	Gasworks	Stickleback	Focal Necrosis	2	14-308	NVL		0-01	NVL		0-01	Bacteremia
												Leucopenia
LU-24	Gasworks	Stickleback	Coccidia	3	14-58	NVL		0-01	Aneurysm	1	314-907	Reticulocytes
			Focal Necrosis	3	14-308							Lobed Rbc Nuc
LU-25	Gasworks	Stickleback	NVL		0-01	NVL		0-01	NVL		0-01	NVL
LU-26	Gasworks	Stickleback	Focal Necrosis	2	14-308	NVL		0-01	Aneurysms	1	314-907	Leucopenia
			Coccidia	1	14-58							
			Nuc Pleo	2	14-406							
LU-27	Gasworks	Stickleback	NVL		0-01	Glomer Pig	1	301-363	Aneurysms	1	314-907	NVL
LU-28	Gasworks	Stickleback	NVL		0-01	NVL		0-01	NVL		0-01	NVL
LU-29	Gasworks	Stickleback	NVL		0-01	NVL		0-01	NVL		0-01	NVL
LU-30	Gasworks	Stickleback	Multiloc Gran	2	73-219	NVL		0-01	NVL		0-01	NVL
LU-31	Gasworks	Stickleback	NVL		0-01	Sporozoa	1	351-58	NVL		0-01	NVL
LU-32	Gasworks	Stickleback	Vacuolation	3	14-482	Nephritis?	?	73-200	Trichodinids	1	314-34	Aniso-Rbc
LU-33	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	NVL
									Trichodinids	2	314-34	
LU-34	Gasworks	Stickleback	Coccidia	2	14-58	NVL		0-01	NVL		0-01	Leucocytosis
LU-35	Gasworks	Stickleback	Nuc Pleo	2	14-406	NVL		0-01	Aneurysms	1	314-907	Aniso-Rbc

* See Appendix 3 for histopathology terms and codes.

Appendix 2 (con't). Catalog of all fish collected and examined.

NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
			Coccidia	3	14-58							
			Intersti Inflam	1	14-200							
			Ser Helminth	1	12-111							
			Focal Necrosis	2	14-308							
LU-36	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	Aniso-Rbc
												Leucopenia
LU-37	Gasworks	Stickleback	NVL		0-01	NVL		0-01	NVL		0-01	NVL
LU-38	Gasworks	Stickleback	Granuloma	1	73-219	Melan Gran	1	73-219	NVL		0-01	NVL
			Par/Ser Helmin	1	14-111							
			Focal Necrosis	1	14-308							
LU-39	Gasworks	Stickleback	Coccidia	2	14-58	NVL		0-01	NVL		0-01	Seg Nuc-Rbc
												Bacteremia
												Vac Macro
LU-40	Gasworks	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	Bacteremia
												Aniso-Rbc
LU-5	Gasworks	Yellow Perch	Mononuc Infil	1	14-234	NVL		0-01	Trichodinids	1	314-34	Leukocytosis
			Basophilic Body		14-127							
LU-6	Gasworks	Yellow Perch	Mononuc Infil	1	14-234	NVL		0-01	Aneurysms	3	314-907	NVL
									Lam. Hyperplasia	3	314-707	
									Lam. Fusion	3	314-707	
LU-63	Gasworks	Yellow Perch	NVL		0-01	NVL		0-01	Trichodinids	1	314-34	Lobul Nuc-Rbc
LU-64	Gasworks	Yellow Perch	NVL		0-01	Vacuol Tub Epi	3	20-482	Trichodinids	2	314-34	NVL
						Mel Casts Lumen	3	0-01	Monogenetic Trem	2	314-100	
						Bowman Dilated	3	0-01	Aneurysms	1	314-907	
						Vac Tub Epi	3	20-482				
LU-65	Gasworks	Yellow Perch	Focal Necrosis	1	14-308	Vac Tub Epi	1	20-482	NVL		0-01	NVL
LU-66	Gasworks	Yellow Perch	Mononuc Infil	1	14-234	NVL		0-01	Monogenetic Trem	1	314-100	Lobul Nuc-Rbc
									Protozoan	1	314-74	
LU-80	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Focal Inflam	1	314-200	NVL
LU-81	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Trichodinids	1	314-34	NVL
LU-83	Gasworks	Yellow Perch	NVL		0-01	NVL		0-01	Monogenetic Trem	1	314-100	NVL
									Trichodinids	1	314-34	
LU-84	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	NVL		0-01	NVL
			Non Uni Vacuol	2	14-483							
			Eosino Focus?	?	14-703?							
			Ser Granuloma	1	12-219							
			Mononuc Infil	1	14-234							
LU-88	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	NVL		0-01	Reticulocytes
			Mononuc Infil	2	14-234							Leukocytosis
			Fibrosis	2	14-261							
LU-94	Gasworks	Yellow Perch	Vacuol	3	14-482	NVL		0-01	Aneurysms	1	314-907	Notch Nuc-Rbc
			Non Uni Vacuol	2	14-483							Aniso-Rbc
LU-95	Gasworks	Yellow Perch	Vacuolation	3	14-482	Tub Epi Inflam	1	20-200	NVL		0-01	NVL
			Focal Inflam	1	14-200							
LU-96	Gasworks	Yellow Perch	Mononuc Infil	1	14-234	NVL		0-01	Aneurysms	1	314-907	Reticulocytes

* See Appendix 3 for histopathology terms and codes.

Appendix 2 (con't). Catalog of all fish collected and examined.

NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
			Non Uni Vacuol	2	14-483							Notch Nuc-Rbc
			Basophil Focus?	?	14-127							
LU-97	Gasworks	Yellow Perch	Vacuolation	3	14-482	Vac Tub Epi	2	20-482	Aneurysms	1	314-907	Leukocytosis
						Tub Epi Inflam	1	20-200	Trichodinids	1	314-34	
LU-102	Gasworks	Yellow Perch	Vacuolation	3	14-482	Focal Inflam	1	73-200	Focal Inflam	1	314-200	No Sample
						Vac Tub Epi	1	20-482				
LU-104	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Aneurysms	1	314-907	NVL
			Mononuc Infil	1	14-234							
			Congestion	2	126-950							
LU-108	Gasworks	Yellow Perch	Vacuolation	2	14-482	NVL		0-01	Focal Hyperpla	1	314-707	NVL
			Mononuc Infil	1	14-234				Monogenetic Trem	1	314-100	
LU-109	Gasworks	Yellow Perch	Vacuolation	2	14-482	Focal Tub Inflam	1	20-200	NVL		0-01	NVL
			Mononuc Infil	1	14-234							
LU-115	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Monogenetic Trem	1	314-100	NVL
			Non Uni Vacuol	1	14-483							
			Basophil Focus	?	14-127							
LU-116	Gasworks	Yellow Perch	Non Uni Vacuol	1	14-483	NVL		0-01	Trichodinids	1	314-34	NVL
			Basophil Focus	?	14-127							
LU-135	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Monogenetic Trem	1	314-100	NVL
LU-136	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Trichodinids	1	314-34	NVL
			Mononuc Infil	1	14-234							
LU-137	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Focal Inflam	1	314-200	NVL
LU-138	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Trichodinids	1	314-34	NVL
LU-139	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Trichodinids	1	314-34	NVL
			Mononuc Infil	1	14-234				Focal Inflam	1	314-200	
LU-118	Gasworks	Yellow Perch	Non Uni Vacuol	1	14-483	Ductular Inflam	1	351-200	Aneurysms	1	314-907	NVL
			Focal Necrosis	1	14-308				Trichodinids	1	314-34	
LU-140	Gasworks	Yellow Perch	Vacuolation	3	14-482	Tub Vac Epi	1	20-482	Focal Inflam	1	314-200	NVL
			Mononuc Infil	1	14-234							
LU-141	Gasworks	Yellow Perch	Vacuolation	3	14-234	NVL		0-01	Aneurysms	1	314-907	NVL
LU-142	Gasworks	Yellow Perch	Vacuolation	2	14-482	Focal Inflam	1	73-200	NVL		0-01	NVL
			Non Uni Vacuol	2	14-483							
LU-143	Gasworks	Yellow Perch	Vacuolation	3	14-482	Eo Dep Glom	1	0-0	Trichodinids	2	314-34	Pyknotic Rbc
			Mononuc Infil	1	14-234				Monogenetic Trem	1	314-100	Aniso Retic
			Non Uni Vacuol	1	14-483							Accen Nuc-Retic
LU-144	Gasworks	Yellow Perch	Non Uni Vacuol	2	14-483	NVL	2	0-01	Aneurysms	1	314-907	NVL
			Mononuc Infil	2	14-234							
LU-145	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	NVL		0-01	NVL
			Mononuc Infil	1	14-234							
LU-146	Gasworks	Yellow Perch	Vacuolation	3	14-482	Granuloma	1	73-219	Trichodinids	1	314-34	NVL
LU-147	Gasworks	Yellow Perch	Non Uni Vacuol	1	14-483	NVL		0-01	Aneurysms	1	314-907	NVL
LU-148	Gasworks	Yellow Perch	Vacuolation	3	14-482	Tub Vac Epi	1	20-482	Aneurysms	1	314-907	NVL
									Focal Inflam	1	314-200	
LU-149	Gasworks	Yellow Perch	Non Uni Vacuol	2	14-483	NVL		0-01	NVL		0-01	NVL
			Mononuc Infil	1	14-234							

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Appendix 2 (con't). Catalog of all fish collected and examined.

NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
			Baso Cells Mmc	?	103-127							
LU-150	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Protozoa	1	314-74	Notch Nuc-Rbc
LU-151	Gasworks	Yellow Perch	Vacuolation	2	14-482	NVL		0-01	Trichodinids	1	314-34	NVL
			Mononuc Infil	1	14-234							
LU-152	Gasworks	Yellow Perch	Vacuolation	2	14-482	NVL		0-01	Focal Inflam	1	314-200	NVL
LU-153	Gasworks	Yellow Perch	Mononuc Infil	1	14-234	NVL		0-01	NVL		0-01	Notch Nuc-Rbc
			Non Uni Vacuol	1	14-483							
LU-154	Gasworks	Yellow Perch	Mononuc Infil	1	14-234	NVL		0-01	Focal Inflam	1	314-200	NVL
LU-155	Gasworks	Yellow Perch	Vacuolation	3	14-482	Tub Vac Epi	1	20-482	Trichodinids	1	314-34	NVL
LU-156	Gasworks	Yellow Perch	Vacuolation	3	14-482	NVL		0-01	Focal Inflam	1	314-200	Reticulocytes
												Aniso-Rbc
LU-77	Gasworks	Sm Bass	Granulomas	3	73-219	NVL		0-01	NVL		0-01	NVL
			Pigmented Macro	2	?							
			Non Uni Vacuol	2	14-483							
LU-87	Gasworks	Sm Bass	Vacuolation	3	14-482	NVL		0-01	Focal Inflam	1	314-200	Leukocytosis
			Granulomas	3	73-219							
			Pigment Macro	2	?							
			Ser Helminth	1	12-111							
			Inflammation	3	14-200							
LU-90	Gasworks	Lm Bass	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	Leukocytosis
LU-91	Gasworks	Lm Bass	Granulomas	2	73-219	Vacuol Epithel	1	20-482	Focal Inflamm	1	314-200	NVL
			Paren Helminth	1	14-111							
			Non Uni Vacuol	1	14-483							
LU-92	Gasworks	Lm Bass	Granulomas	2	73-219	NVL		0-01	Focal Inflam	1	314-200	Reticulocytes
			Non Uni Vacuol	3	14-483							Accen Nuc-Rbc
LU-101	Gasworks	Lm Bass	Focal Inflam	3	14-200	NVL		0-01	NVL		0-01	Crenated-Rbc
			Granulomas	3	73-219							
			Intes Adhesion	3	12-264							
			Vacuolation	2	14-482							
			Non Uni Vacuol	2	14-483							
LU-110	Gasworks	Lm Bass	Granulomas	2	73-219	NVL		0-01	NVL		0-01	Poikilo-Rbc
												Accen Nuc-Rbc
LU-67	Gasworks	Pumpkinseed	Focal Pigment	2	?	NVL		0-01	NVL		0-01	Aniso-Rbc
												Lobul Nuc-Rbc
LU-98	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	Encys Parasite	1	73-111	Focal Inflam	1	314-200	NVL
						Inter Nephritis	1	73-200				
LU-103	Gasworks	Pumpkinseed	NVL		0-01	NVL		0-01	Monogenetic Trem	1	314-100	Pyk/Karyo-Mac
												Ghost Rbc
LU-105	Gasworks	Pumpkinseed	Non Uni Vacuol	2	14-483	NVL		0-01	Aneurysms	2	314-907	Notch Nuc-Rbc
			Increase Mmc	2	103-726							
			Mononuc Infil	1	14-234							
			Basophil Cluster	?	14-127							
LU-106	Gasworks	Pumpkinseed	Non Uni Vacuol	1	14-483	NVL		0-01	Trichodinids	1	314-34	NVL
LU-107	Gasworks	Pumpkinseed	Focal Necrosis	1	14-308	NVL		0-01	Focal Inflam	1	314-200	NVL
LU-117	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Stalked Ciliates	1	314-33	NVL

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NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
			Non Uni Vacuol	1	14-483				Monogenetic Trem	1	314-100	
LU-157	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	NVL		0-01	Aniso-Rbc Accen Nuc-Rbc Lobul Nuc-Rbc Notch Nuc-Rbc
LU-159	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Aneurysms	1	314-907	Notch Nuc-Rbc
LU-160	Gasworks	Pumpkinseed	NVL		0-01	NVL		0-01	Monogenetic Trem	1	314-100	NVL
LU-161	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	NVL		0-01	NVL
			Paren Helminth	1	14-111							
LU-162	Gasworks	Pumpkinseed	Granuloma	2	73-219	NVL		0-01	NVL		0-01	Leucopenia
			Mononuc Infil	2	14-234							
			Ser Helminth	1	12-111							
LU-163	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	Focal Inflam	2	73-200	NVL		0-01	NVL
LU-164	Gasworks	Pumpkinseed	NVL		0-01	NVL		0-01	NVL		0-01	Lobul Nuc-Rbc
LU-165	Gasworks	Pumpkinseed	Degen Parasite	1	14-111	NVL		0-01	NVL		0-01	NVL
			Paren Helminth	1	14-111							
LU-166	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Monogenetic Trem	1	314-100	NVL
LU-167	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Monogenetic Trem	1	314-100	Leucopenia
LU-168	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Monogenetic Trem	1	314-100	Leucopenia
LU-169	Gasworks	Pumpkinseed	Focal Necrosis	1	14-308	NVL		0-01	Aneurysms	1	314-907	NVL
			Mononuc Infil	1	14-234							
LU-170	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Monogenetic Trem	1	314-100	Leucopenia
									Aneurysms	1	314-907	
LU-171	Gasworks	Pumpkinseed	Mononuc Infil	1	14-234	Focal Inflam	1	73-200	NVL		0-01	NVL
LU-7	Gasworks	Sculpin	NVL		0-01	NVL		0-01	Aneurysms	1	314-907	NVL
LU-112	Gasworks	Sculpin	Nuc Pleo	2	14-406	NVL		0-01	Focal Inflam	1	314-200	NVL
			Non Uni Vacuol	2	14-483							
			Focal Necrosis	1	14-308							
LU-113	Gasworks	Sculpin	Nuc Pleo	2	14-406	NVL		0-01	Stalked Ciliates	1	314-33	Accen Nuc-Rbc
			Non Uni Vacuol	1	14-483							
			Mononuc Infil	1	14-234							
			Increase Mmc	1	103-726							
LU-114	Gasworks	Sculpin	Nuc Pleo	2	14-406	NVL		0-01	Aneurysms	1	314-907	Accen Nuc-Rbc
			Non Uni Vacuol	1	14-483				Protozoa	1	314-74	
LU-119	Gasworks	Bullhead	Congestion	2	126-950	NVL		0-01	NVL		0-01	NVL
LU-174	Gasworks	Bullhead	Vacuolation	2	14-482	NVL		0-01	NVL		0-01	Leucopenia
			Congestion	1	126-950							
LU-74	Gasworks	Trout	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-79	Gasworks	Trout	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-85	Gasworks	Trout	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-99	Gasworks	Trout	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-100	Gasworks	Trout	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-75	Gasworks	Sucker	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-76	Gasworks	Sucker	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-89	Gasworks	Sucker	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined

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NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
LU-82	Gasworks	Chub	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-86	Gasworks	Chub	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-93	Gasworks	Bluegill	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-158	Gasworks	Bluegill	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-172	Gasworks	Crappie	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-173	Gasworks	Crappie	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-78	Gasworks	Squawfish	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-111	Gasworks	Starry Floun.	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-1	Navy Cove	Pumpkinseed	Foc Vasc Conges	1	126-950	NVL		0-01	Mult. Aneurysms	1	314-907	NVL
LU-2	Navy Cove	Pumpkinseed	Focal Necrosis	1	14-308	NVL		0-01	NVL		0-01	NVL
LU-3	Navy Cove	Pumpkinseed	NVL		0-01	NVL		0-01	Interlam. Parasites	1	314-185	NVL
LU-4	Navy Cove	Pumpkinseed	Fluid Filled Cyst	2	14-902	Granuloma	1	73-219	NVL		0-01	Leukocytosis
LU-185	Navy Cove	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	NVL		0-01	Leucopenia
LU-186	Navy Cove	Pumpkinseed	Mononuc Infil	1	14-234	Foc Inflam	1	73-200	NVL		0-01	Notch Nuc-Rbc
			Granuloma	2	73-219							Leucopenia
LU-187	Navy Cove	Pumpkinseed	Mononuc Infil	1	14-234	NVL		0-01	Focal Inflam	2	314-200	NVL
LU-188	Navy Cove	Pumpkinseed	Increase Mmc	1	103-726	NVL		0-01	Monogenetic Trem	1	314-100	Notch Nuc-Rbc
												Lobul Nuc-Rbc
LU-68	Navy Cove	Pumpkinseed	NVL		0-01	Focal Necrosis	1	73-308	Protozoan	1	314-74	NVL
LU-41	Navy Cove	Stickleback	Not On Slide	N/A	0-0	Tub Vacuol	2	20-482	Trichodinids	1	314-34	Bacteremia
									Aneurysms	1	314-907	Aniso-Rbc
LU-42	Navy Cove	Stickleback	Non Uni Vacuol	1	14-483	Foc Nec	1	73-308	NVL		0-01	Conden Chrom
LU-43	Navy Cove	Stickleback	Vacuolation	3	14-482							
			Necrosis-Cystic	1	14-308	Not On Slide	N/A	0-0	Encysted Helminth	1	314-111	Reticulocytes
									Monogenetic Trem	1	314-100	
LU-44	Navy Cove	Stickleback	Focal Necrosis	1	14-308	NVL		0-01	NVL		0-01	Conden Nuc Rbc
			Coccidia	2	14-58							Accen Nuc-Rbc
LU-45	Navy Cove	Stickleback	Vcuolation	3	14-482	NVL		0-01	NVL		0-01	Rosettes
			Focal Inflam	1	14-200							
			Non Uni Vacuol	1	14-483							
LU-46	Navy Cove	Stickleback	Non Uni Vacuol	2	14-483	NVL		0-01	NVL		0-01	Aniso-Rbc
			Ser Helminths	1	12-111							Accen Nuc-Rbc
			Focal Necrosis	2	14-308							
			Spongiosis	1	14-720							
LU-47	Navy Cove	Stickleback	Granulomas	1	73-219	NVL		0-01	Trichodinids	1	314-34	NVL
			Focal Necrosis	2	14-308							
			Non Uni Vacuol	1	14-483							
LU-48	Navy Cove	Stickleback	NVL		0-01	NVL		0-01	Aneurysms	2	314-907	Bacteremia
LU-49	Navy Cove	Stickleback	NVL		0-01	NVL		0-01	Trichodinids	1	314-34	Conden Nuc-Rbc
									Aneurysms	1	314-907	Accen Nuc-Rbc
LU-50	Navy Cove	Stickleback	Not On Slide	N/A	0-0	NVL		0-01	Trichodinids	1	314-34	Bacteremia
									Foc Hyperplasia	1	314-707	Macro Necrosis
									Aneurysms	1	314-907	
LU-51	Navy Cove	Stickleback	Vacuolation	3	14-482	NVL		0-01	Monogenetic Trem	2	314-100	NVL
			Encap Cyst	2	14-902							

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NO.	STATION	SPECIES	LIVER*	SEV.	CODE*	KIDNEY	SEV.	CODE	GILL	SEV.	CODE	BLOOD
			Focal Necrosis	2	14-308							
			Non Uni Vacuol	1	14-483							
LU-52	Navy Cove	Stickleback	Vacuolation	3	14-482	NVL		0-01	Trichodinids	2	314-34	NVL
			Hemorrhage	1	133-959							
			Focal Necrosis	1	14-308							
LU-53	Navy Cove	Stickleback	Vacuolation	3	14-482	NVL		0-01	Monogenetic Trem	1	314-100	NVL
			Focal Fibrosis	1	14-261				Trichodinids	1	314-34	
			Encap Gran	1	73-219							
LU-54	Navy Cove	Stickleback	Vacuolation	3	14-482	NVL		0-01	Aneurysms	1	314-907	Bacteremia
			Spongiosis	1	14-720							
			Granuloma	1	73-219							
LU-55	Navy Cove	Stickleback	Vacuolation	3	14-482	NVL		0-01	NVL		0-01	Accen Nuc-Rbc
			Non Uni Vacuol	3	14-483							
			Focal Necrosis	2	14-308							
			Ser Helminth	1	12-111							
			Nuc Pleomor	2	14-406							
			Granulomas	3	73-219							
LU-56	Navy Cove	Yellow Perch	NVL		0-01	Not On Slide	N/A	0-0	Trichodinids	1	314-34	NVL
LU-57	Navy Cove	Yellow Perch	Focal Necrosis	1	14-308	NVL		0-01	NVL		0-01	NVL
LU-58	Navy Cove	Yellow Perch	Granuloma	1	73-219	NVL		0-01	Monogenetic Trem	1	314-100	NVL
			Mononuc Infil	1	14-234				Bifurcated Lam	1	0-01	
LU-59	Navy Cove	Yellow Perch	Clear Cell Focus?	1	14-308			0-01		1	314-907	
LU-60	Navy Cove	Yellow Perch	Focal Necrosis	1	14-308	NVL		0-01	Aneurysms	3	314-907	NVL
LU-61	Navy Cove	Yellow Perch	Focal Necrosis	1	14-483	NVL	1	300-356	Aneurysms	2	314-907	Conden Nuc-Rbc
LU-62	Navy Cove	Yellow Perch		1	14-234			0-01	Monogenetic Trem	1	314-34	
			Non Uni Vacuol	1	14-483	Calculus			Aneurysms	1	314-74	Lobul Nuc-Rbc
LU-175	Navy Cove	Yellow Perch	Mononuc Infil	1	14-483	NVL		0-01	Trichodinids	1	314-100	NVL
LU-176	Navy Cove	Yellow Perch	Non Uni Vacuol	3	14-482		1	20-482	Protozoan	3	314-907	
			Non Uni Vacuol			NVL			Monogenetic Trem	1	314-100	NVL
LU-177	Navy Cove	Yellow Perch	Vacuolation	3	14-482	Vac Tub Epi		0-01	Aneurysms		0-01	Leucopenia
				1	14-234				Monogenetic Trem			
LU-178	Navy Cove	Yellow Perch	Vacuolation	3	14-234	NVL		0-01	NVL		0-01	NVL
			Mononuc Infil	1	14-483							
			Mononuc Infil	2	12-200	NVL			NVL			NVL
LU-179	Navy Cove	Yellow Perch	Non Uni Vacuol	3	14-482			0-01		1	314-34	
LU-180	Navy Cove	Yellow Perch	Serositis	2	14-482		1	20-482			0-01	
LU-181	Navy Cove	Yellow Perch	Vacuolation	2	14-482	NVL	1	20-482	Trichodinids	1	314-34	Leucopenia
			Vacuolation	1	14-234	Vac Tub Epi			NVL			NVL
LU-182	Navy Cove	Yellow Perch	Vacuolation	2	14-482	Vac Tub Epi	1	20-482	Trichodinids		0-01	NVL
			Mononuc Infil	1	14-483							
LU-183	Navy Cove	Yellow Perch	Vacuolation	3	14-482	Vac Tub Epi		0-01	NVL		0-01	Leucopenia
LU-184	Navy Cove	Yellow Perch	Non Uni Vacuol	3	14-482		1	20-482		1	314-74	
LU-69	Navy Cove	Sculpin	Vacuolation	3	73-219	NVL		0-01	NVL	1	314-74	NVL
			Vacuolation	3	14-482	Vac Tub Epi			Protozoa	1	314-907	Leucopenia
			Granulomas	2	14-308	NVL			Protozoan			Aniso

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			Vacuolation	2	14-234				Aneurysm			Reticulocytes
LU-70	Navy Cove	Sculpin	Focal Necrosis	N/A	?			0-01		1	314-33	Accen Nuc-Rbc
			Mononuc Infil	1	14-305							Enucle-Rbc
LU-71	Navy Cove	Sculpin	Structure?	1	14-234	NVL		0-01	Stalked Protozoan	2	314-707	Aniso-Rbc
			Fatty Infil	2	14-261					2	314-707	Senescent Rbc
			Mononuc Infil	2	14-406	NVL			Lamellar Hyperpla	1	314-907	NVL
			Fibrosis	?	?				Lamellar Fusion	1	314-100	
LU-72	Navy Cove	Sculpin	Nuclear Pleo	2	14-482			0-01	Aneurysms	1	314-907	
			Clusters Of Ducts	?	?				Monogenetic Trem?	1	314-74	
LU-73	Navy Cove	Sculpin	Vacuolation	2	14-483	NVL		0-01	Aneurysms	2	314-33	NVL
			Cluster Of Ducts	1	14-406				Protozoan			
LU-120	Navy Cove	Squawfish	Non Uni Vacuol	N/A	0-0	NVL	N/A	0-0	Stalked Ciliates	N/A	0-0	Aniso-Rbc
LU-121	Navy Cove	Squawfish	Nuclear Pleo	N/A	0-0		N/A	0-0		N/A	0-0	Lobul Nuc-Rbc
LU-122	Navy Cove	Squawfish	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-124	Portage Bay	Yellow Perch	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-127	Portage Bay	Yellow Perch	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-128	Portage Bay	Yellow Perch	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-133	Portage Bay	Yellow Perch	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-125	Portage Bay	Pumpkinseed	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-126	Portage Bay	Pumpkinseed	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-130	Portage Bay	Pumpkinseed	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-132	Portage Bay	Pumpkinseed	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-129	Portage Bay	Lm Bass	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-134	Portage Bay	Lm Bass	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-131	Portage Bay	Crappie	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined
LU-123	Portage Bay	Sucker	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined	N/A	0-0	Not Examined

* See Appendix 3 for histopathology terms and codes.

APPENDIX 3

HISTOPATHOLOGY TERMS AND CODES

ORGAN CODES

Liver (1)
Kidney (2)
Gills (3)

LESION SEVERITY CODES

Mild (1)
Moderate (2)
Severe (3)

HEPATOCELLULAR VACUOLATION CODES *

No vacuolation (0)
Minimal vacuolation (1)
Moderate vacuolation (2)
Extensive vacuolation (3)

LESION CODES

GENERAL

NVL--no visible lesions (0-01)
Not Examined--specimen not examined (0-0)
Not On Slide--tissue not present on slide (0-0)
Not Present--tissue not present on slide (0-0)

LIVER

Adhesion--fibrous attachment of liver serosa to adjacent organ, result of inflammation (12-264)
Baso Hepatocytes--focus of increased basophilia (14-127)
Baso MMCs--presence of basophilic cells in melanin macrophage center (103-127)
Coccidia--coccidian parasites in liver tissue (14-58)
Congestion--vascular hyperemia, probably not pathologic (126-950)
Dark MMC--increased pigmentation in melanin macrophage centers (103-726) **
Dead Para--dead encapsulated parasite in tissue (14-111)
Encap Para--encapsulated helminth parasite (14-111)
Eosin Nod--nodular focus of increased eosinophilia (14-703)
Fatty Infiltration--presence of adipose tissue in liver parenchyma (14-305)
Fibrosis--proliferation of connective tissue in liver parenchyma (14-261)
Foc Nec--focal necrosis in hepatocytes (14-308)
Focal Inflam--spherical, active inflammatory focus (14-200)
Granuloma (Granulomas)--a chronic inflammatory lesion (or lesions) generally associated with parasitism (73-219)
Helm Gran--granuloma formed around helminth parasite (73-219)
Hemorrhage--rupture of small vessels or sinusoids (133-959)
MMC Dark--increased pigmentation in melanin macrophage centers (103-726) **

MMCs--increased pigmentation in melanin macrophage centers (103-726) **
Mitotic Figure--increased mitotic activity in hepatocytes (14-529)
Mono Infil--mononuclear cell infiltration; irregularly shaped aggregates or fingers of mononuclear cells (a type of inflammatory change) (14-234)
Necrosis--focal necrosis in hepatocytes (14-308)
Non Uni Vac--non uniform vacuolation of hepatocytes (14-483)
Nuc Pleo--nuclear pleomorphism in hepatocytes (14-406)
Para Cyst--helminth parasite in cystic space (14-902)
Paren Cyst--cyst formation in parenchyma of liver (14-902)
Parenc Hel--encapsulated, parenchymal parasite (14-111)
Ser Helmin--serosal helminth (12-116)
Serositis--serosal inflammation (12-200)
Spong Hep--spongiosis hepatis; cystic spaces in liver parenchyma (14-720)
Sporozoa--sporozoan parasite in lumen of bile duct (72-58)
Vacuolation--degree of hepatocellular lipid vacuolation (14-482)*

KIDNEY

Calculus--presence of uroliths within portion of nephron (300-356)
Duc Inflam--inflammatory cells in ductular epithelium (351-200)
Encap Para--encapsulated helminth parasite (73-111)
Foc Necrosis--necrosis of interstitial tissue (73-308)
Glomer Pig--presence of unidentified pigment in glomerulus (301-363)
Granuloma (Granulomas)--a chronic inflammatory lesion (or lesions) generally associated with parasitism (73-219)
Inflam--inflammatory focus in interstitial tissue (73-200)
Necrosis--necrosis of interstitial tissue (73-308)
Nephritis--inflammatory focus in interstitial tissue (73-200)
Periduc Infl--inflammation surrounding collecting duct (73-200)
Sporo Duct--sporozoan parasites in lumen of collecting duct (351-58)
Sporozoa--sporozoan parasites in lumen of collecting duct (351-58)
Tub Inflamm-inflammatory cells in epithelium of tubule (20-200)
Vac Tub Epi--vacuolation of tubular epithelium (20-482)

GILLS

Aneurysm (Aneurysms)--aneurysms; localized dilation of capillary lumen (314-907)
Encap Para--encapsulated parasite (313-111)
Foc Hyperpl--focal hyperplasia of lamellar epithelium (314-707)
Focal Inflam--focal inflammation of lamellae (314-200)
Helminth--presence of unidentified helminth parasite on gill lamellae (314-111)
Hyperplas--focal hyperplasia of lamellar epithelium (314-707)
Monogenetic Trem--presence of monogenetic trematode on gill lamellae (314-100)
Parasite--presence of unidentified parasite on gill lamellae (314-185)
Protozoan--presence of unidentified protozoan parasite on gill lamellae (314-74)
Stalked Cil--presence of stalked ciliates on gill lamellae (314-33)
Trichodinids--presence of Trichodina sp. between gill lamellae (314-34)

BLOOD

Accen Nuc RBC/Reticulocyte--acentric nucleus in mature or immature red blood cell

Aniso-RBC/Reticulocyte--anisocytosis of mature or immature red blood cells; cell size different (usually larger) from normal
Bacteremia--presecne of bacteria in blood stream
Crenated RBC--cell membrane of red blood cell highly folded
Ghost RBC--remnants of red blood cell outlines; dead cells
Karyol-WBC--karyolysis of white blood cell nucleus
Leucocytosis--increased number of white blood cells; often a sign of active infection or inflammation
Leukopenia--decreased number of white blood cells; often a sequella of infection
Lobed RBC Nuclei--abnormally shaped nucleus in red blood cell; lobed
Notch Nuc RBC--abnormally shaped nucleus in red blood cell; notched
Poikilo RBC--red blood cells of mixed sizes and shapes
Pyknotic RBC--nuclear chromatin in red blood cell condensed
Regen Anemia--regenerative anemia
Reticulocytes--presence of immature red blood cells
Rosette-RBC--Clusters of white blood cells around red blood cell
Seg Nuc RBC--abnormally shaped nucleus in red blood cell; segmented
Vac Macro--activated (vacuolated) macrophages

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* Hepatocellular vacuolation is not a pathological lesion. Rather it reflects changes in physiological state.

** Increased pigmentation of melanin macrophage centers is a condition that frequently accompanies chronic exposure to contaminants, but that may also be encountered in animals of advanced age. The verbal descriptors used in the data set are synonyms that were used interchangably to describe the condition that is coded 103-726.