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# Assessment of Skin and Liver Neoplasms in Brown Bullhead (*Ameiurus nebulosus*) Collected at the Ashtabula River Area of Concern and Associated Reference Site, Ohio, in 2016

Open-File Report 2018–1072

U.S. Department of the Interior
U.S. Geological Survey

**Cover.** Brown bullhead from the Ashtabula River illustrating the external tumors observed. Photograph by Vicki S. Blazer, U.S. Geological Survey.

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RYAN K. ZINKE, Secretary

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James F. Reilly II, Director

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# Conversion Factors

International System of Units to U.S. customary units

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| centimeter (cm) | 0.3937 | inch (in.) |
| millimeter (mm) | 0.03937 | inch (in.) |
| meter (m) | 3.281 | foot (ft) |
| kilometer (km) | 0.6214 | mile (mi) |
| | Volume | |
| liter (L) | 0.2642 | gallon (gal) |

# Assessment of Skin and Liver Neoplasms in Brown Bullhead (*Ameiurus nebulosus*) Collected at the Ashtabula River Area of Concern and Associated Reference Site, Ohio, in 2016

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## Abstract

Brown bullhead (*Ameiurus nebulosus*) is a commonly used indicator species for tumor surveys at Great Lakes Areas of Concern. The "fish tumors or other deformities" is one of the beneficial use impairments at the Ashtabula River Area of Concern. In May 2016, 150 brown bullhead were collected in the lower Ashtabula River and 150 were collected in the nearby Conneaut Creek as a reference. Length, weight and external visible abnormalities were documented. Fish were euthanized, and skin lesions and liver tissue preserved for histopathological analyses. Otoliths were collected for age analyses. The percentage of bullhead with raised external lesions on lips, barbels and body surface was 34.7 percent at the Ashtabula River and 23.3 percent at Conneaut Creek. At the Ashtabula River, 26.7 percent of the bullhead collected had skin neoplasms, including papillomas, melanomas and squamous cell carcinomas, whereas at Conneaut Creek 18.6 percent had only papillomas, benign skin tumors. Liver neoplasms were observed in 7.3 percent of the bullhead from the Ashtabula River and 4.7 percent of those from Conneaut Creek. These neoplasms were observed in fish 6 years of age or older at both sites.

## Introduction

The Ashtabula River, located in northeastern Ohio, was contaminated with many industrial chemicals, primarily as a result of decades of metals fabrication, chemical production and waste disposal along Fields Brook, a U.S. Environmental Protection Agency (EPA) Superfund site. The lowermost 2 miles (3.2 kilometers) of river was listed as a Great Lakes Area of Concern (AOC) by the International Joint Commission under the 1987 Great Lakes Water Quality Agreement on the basis of six Beneficial Use Impairments (BUIs) including fish tumors or other deformities. In this agreement, the fish tumor BUI was defined as occurring "when the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullhead or suckers." Remediation projects were initiated and cleanup was completed in 2014, with the last dredging occurring in 2013. One of the remaining BUIs is fish tumors or other deformities. According to the 2014 Delisting Guidance and Restoration Targets for Ohio Areas of Concern (http://epa.ohio.gov/portals/35/lakeerie/Ohio_AOC_Delisting_Guidance.pdf, accessed December 14, 2017), the State of Ohio's guideline states this beneficial use is impaired if "DELTs (deformities, eroded fins, lesions and tumors) or bullhead liver tumor incidence levels exceed regional target values or values found in other fish populations and are due to contaminant sources from within the boundaries of the AOC." The AOC restoration target states the average DELT values within the assessment unit should not exceed 3 percent for lacustuary and boat sites and the prevalence rate of brown bullhead liver tumors (in other words, neoplastic and preneoplastic liver lesions ) should not exceed 5 percent. In 2016 an additional revision for this BUI states the minimum age for brown bullhead used in tumor assessments is 3 years (http://epa.ohio.gov/Portals/35/lakeerie/FINAL-%20Delist%20Guid%20%20Rest%20Targets%20for%20Ohios%20AOCs_January2016.pdf, accessed December 14, 2017).

## Methods

### Field Methods

During Spring 2016 (May 17–18) adult brown bullhead (150 at each site) were collected by Ohio Environmental Protection Agency, EPA and U.S. Fish and Wildlife Service personnel from the lower Ashtabula River and the nearby reference site on Conneaut Creek. Fish with a total length of

250 millimeters and greater were targeted in order to meet the minimum age criterion of 3 years.

Fish were euthanized with a lethal aqueous dose of MS-222 (500 milligrams per liter) immediately prior to necropsy. Necropsies were performed by personnel from the USGS, Leetown Science Center (LSC), with assistance from the other agencies, in accordance with the LSC laboratory animal care and use policy as well as the associated Institutional Animal Care and Use Committee (IACUC)-approved protocol. Bullhead were weighed, measured, and examined for any grossly visible abnormalities. Pieces of liver (5–7 discrete areas) as well as any skin lesions were placed into Z-fix® (Anatech Ltd., Battle Creek, Michigan) for preservation. External abnormalities including red and eroded lesions; melanistic spots on body surfaces; raised, pale to reddened lesions in the oral cavity and body surfaces; and missing, shortened, deformed, or knobbed (having raised areas) nasal, maxillary, and chin barbels were recorded. Prevalence was calculated by number of fish with each abnormality divided by total number of fish multiplied by 100 percent. Otoliths were removed for aging.

## Laboratory Methods

Tissues for microscopic examination were processed in the Histology Laboratory, USGS LSC. Processing and evaluation of otoliths was also performed at LSC as previously described (Blazer and others, 2014). During the delisting process for the Presque Isle Bay (Pennsylvania) AOC, workshops were convened to address inconsistent methodology and interpretation of the fish tumor BUI (Rafferty and others, 2009). One outcome of these workshops was a consensus, of pathologists experienced in fish tumor pathology, on diagnostic criteria that should be used for skin and liver tumors (Blazer and others, 2006, 2007). Prepared slides were evaluated according to these criteria. Neoplastic changes and other proliferative changes, including bile duct proliferation and foci of cellular alteration, were documented.

# Assessment of Skin and Liver Neoplasms

At the Ashtabula River site, 64 female, 85 male, and 1 intersex bullhead, ranging in age from 3 to 15 years, were collected and processed. There were four fish for which no useable otoliths were collected. The age distribution is presented in figure 1*A*.

At the Conneaut Creek site, 66 female, 82 male, and 2 undetermined brown bullhead, ranging in age from 3 to 11 years, were collected and processed. There were five fish from which no useable otoliths were collected. The age distribution is presented in figure 1*B*. The collection from Conneaut Creek included more 4-year-old and fewer 6-year-old brown bullhead than the collection from the Ashtabula River.

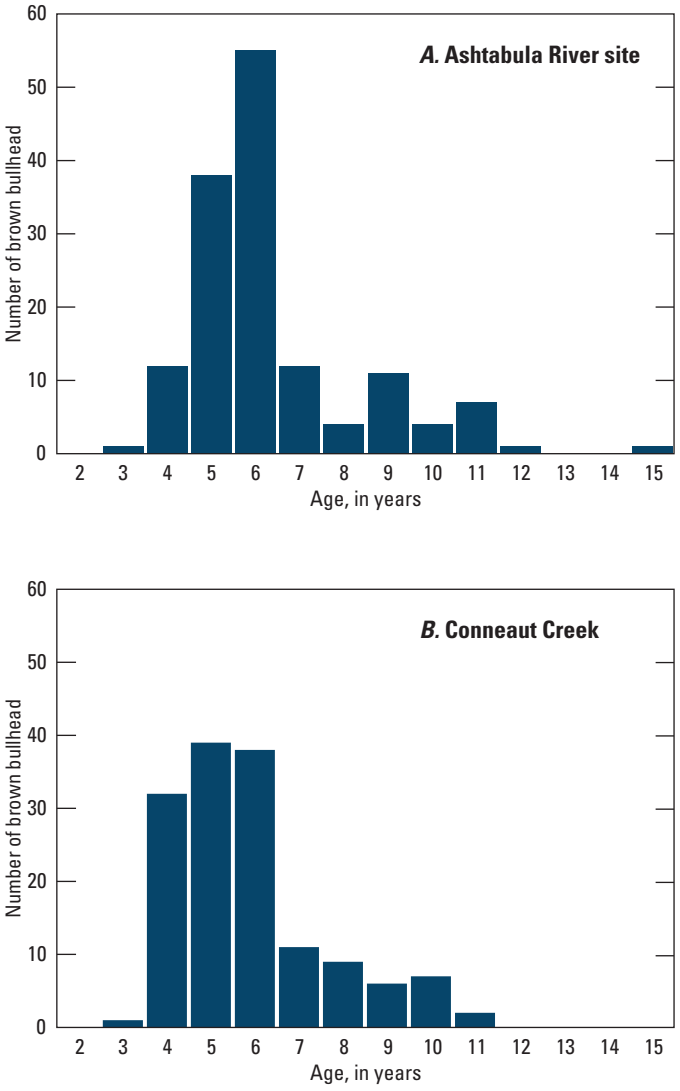


**Figure 1.** Number of brown bullhead collected in each age class, May 2016 at (*A*) the Ashtabula River site, Ohio, and (*B*) Conneaut Creek, Ohio.

## External Lesions Observed

Visible abnormalities observed included large raised pale to reddish, papillomatous growths on the lips (fig. 2*A*) and body surface (fig. 2*B*), raised black lesions on the body surface (fig. 2*C*), raised areas on the barbels, non-raised melanistic (black) lesions (fig. 2*D*) and reddened or eroded lesions.

## External Lesion Prevalence

Fifty-four percent of the brown bullhead collected at the Ashtabula River appeared normal on external examination, having no body surface (including fins), barbel, or lip

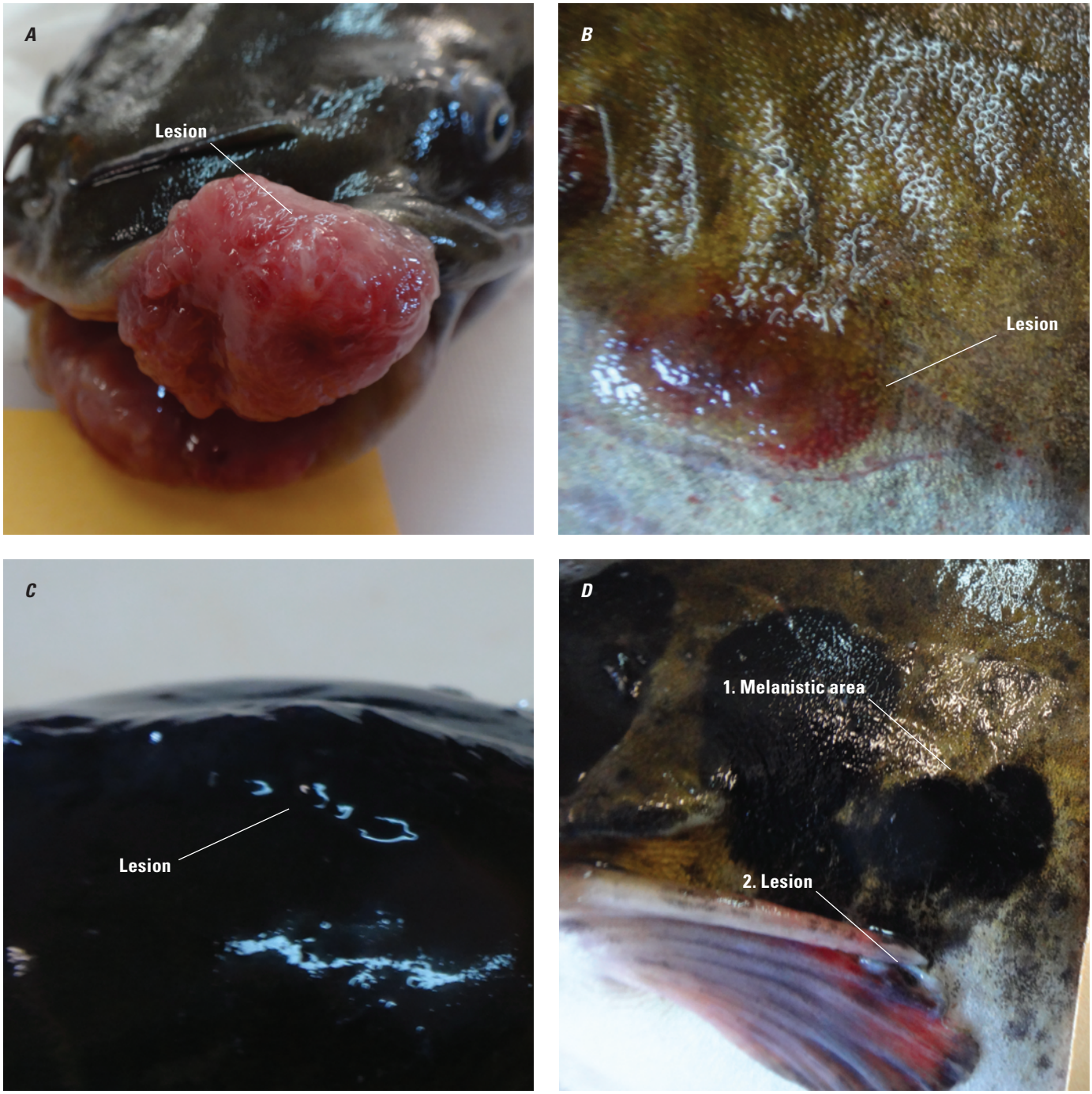


**Figure 2.** Visible abnormalities observed on brown bullhead collected at the Ashtabula River and Conneaut Creek sites, Ohio, May 2016: *A*. Large pale, reddish lip lesion (arrow). *B*. Reddish raised body surface lesion (arrow). *C*. Raised black body surface lesion (arrow). *D*. Non-raised melanistic area (arrow 1) and a raised lesion on the fin (arrow 2) with black pigmentation surrounding it. Photos V. Blazer

abnormalities. A slightly higher percentage (58 percent) of the brown bullhead collected at Conneaut Creek appeared normal. A higher percentage of bullhead with either raised lip and body surface lesions, barbels with raised areas, or melanistic areas was observed in fish collected from the Ashtabula River than those collected from Conneaut Creek. In contrast, red or eroded areas and other barbel abnormalities were more common in bullhead collected from Conneaut Creek (table 1).

## Skin Tumor Prevalence

Not all of the visually observed raised lesions were neoplasms. Skin neoplasms included papilloma (the only type observed at Conneaut Creek), and squamous cell carcinoma, and melanoma, all of which were observed in fish collected from the Ashtabula River. Skin neoplasia occurred in bullhead 4 or more years of age at both sites (table 2). The prevalence of skin tumors was 26.7 percent at the Ashtabula River and 18.6 percent at Conneaut Creek. In addition to the skin neoplasms, some of the raised lesions, generally smooth and on the fins, were osteomas. These tumors were observed at both sites with a prevalence of 9 percent at the Ashtabula River and 2 percent at Conneaut Creek. Because osteomas are bone neoplasms they were not included in the skin neoplasm age distribution (table 2) or overall prevalence of skin neoplasms.

**Table 1.** Visible abnormalities on brown bullhead collected from the Ashtabula River and Conneaut Creek, Ohio, May 2016, in percent.

| Abnormality | Ashtabula River | Conneaut Creek |
|---|---|---|
| Red or eroded lesions | 6.0 | 9.3 |
| Raised lip and body surface | 24.7 | 18.6 |
| Melanistic areas | 18.0 | 15.3 |
| Barbel[1] | 17.3 | 20.7 |
| Knobbed or raised barbel | 10.0 | 4.7 |
| Normal individuals (no abnormalities) | 54.0 | 58.0 |

[1]Includes missing, shortened and deformed.

## Liver Tumor Prevalence

A total of 11 (7.3 percent) brown bullhead from the Ashtabula River and 7 (4.7 percent) from Conneaut Creek had liver neoplasms, including hepatic cell adenoma and carcinoma, cholangioma, and cholangiocarcinoma. Liver neoplasms were observed in bullhead 6 years of age and older at both sites (table 3). A variety of types of foci of cellular alteration, including eosinophilic, vacuolated and basophilic, were observed at both sites. Although investigators have identified one or more types of these foci to be preneoplastic in some fish species, there have been no conclusive studies in brown bullhead to indicate which, if any, will progress to actual neoplasms. Therefore, it has been suggested that although they

**Table 2.** Age distribution of brown bullhead with skin neoplasms collected from the Ashtabula River and Conneaut Creek, Ohio, May 2016.

| Age | Ashtabula River | | Conneaut Creek | |
|---|---|---|---|---|
| | Total number of fish collected | Number of fish with neoplasms | Total number of fish collected | Number of fish with neoplasms |
| 3 | 1 | 0 | 1 | 0 |
| 4 | 12 | 1 | 32 | 2 |
| 5 | 38 | 4 | 38 | 4 |
| 6 | 55 | 14 | 39 | 7 |
| 7 | 12 | 5 | 11 | 5 |
| 8 | 4 | 2 | 9 | 0 |
| 9 | 11 | 6 | 6 | 4 |
| 10 | 4 | 1 | 7 | 3 |
| 11 | 7 | 5 | 2 | 0 |
| 12 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 |
| 15 | 1 | 1 | 0 | 0 |
| Unknown | 4 | 0 | 5 | 2 |
| Totals | 150 | 40 | 150 | 27 |

**Table 3.** Age distribution of brown bullhead with liver neoplasms collected from the Ashtabula River and Conneaut Creek, Ohio, May 2016.

| Age | Ashtabula River | | Conneaut Creek | |
|---|---|---|---|---|
| | Total number of fish collected | Number of fish with neoplasms | Total number of fish collected | Number of fish with neoplasms |
| 3 | 1 | 0 | 1 | 0 |
| 4 | 12 | 0 | 32 | 0 |
| 5 | 38 | 0 | 38 | 0 |
| 6 | 55 | 2 | 39 | 1 |
| 7 | 12 | 0 | 11 | 1 |
| 8 | 4 | 1 | 9 | 0 |
| 9 | 11 | 3 | 6 | 1 |
| 10 | 4 | 1 | 7 | 2 |
| 11 | 7 | 3 | 2 | 2 |
| 12 | 1 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 |
| 15 | 1 | 1 | 0 | 0 |
| Unknown | 4 | 0 | 5 | 0 |
| Totals | 150 | 11 | 150 | 7 |

are documented as indicators of exposure to contaminants they should not be included in the calculation of tumor prevalence (Blazer and others, 2006, 2007). The prevalence of altered foci was 21.3 percent at the Ashtabula River and 14.0 percent at Conneaut Creek.

## Summary

This study was conducted to determine the current prevalence of skin and liver neoplasms in brown bullhead collected within the Ashtabula River Area of Concern, Ohio. In May 2016,150 adult bullhead were collected from the Ashtabula River (table 4) and 150 from a nearby reference site, Conneaut Creek, Ohio (table 5). Fish were euthanized, weighed, measured and examined for visible abnormalities. Pieces of skin abnormalities and liver were preserved, processed for microscopic evaluation and used to diagnoses neoplasms.

Skin neoplasms including papillomas, melanomas, and squamous cell carcinomas were documented in 26.7 percent of brown bullhead from the Ashtabula River, whereas only papillomas were documented in 18.6 percent of bullheads from Conneaut Creek. In liver hepatic cell and bile duct neoplasms were observed in 7.3 percent of bullheads from the Ashtabula River and 4.7 percent of those from Conneaut Creek.

**Table 4.** Morphometric data, visible and microscopic abnormalities: Ashtabula River, Ohio, May 2016.

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body, and barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| ASH16-1 | 5/16/2016 | 370 | 576 | M | 9 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | SCC | 0 | 1 | 0 | CO |
| ASH16-2 | 5/16/2016 | 331 | 503 | F | 8 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | CO |
| ASH16-3 | 5/16/2016 | 355 | 583 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-4 | 5/16/2016 | 356 | 560 | F | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-5 | 5/16/2016 | 310 | 392 | M | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-6 | 5/16/2016 | 355 | 698 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-7 | 5/16/2016 | 390 | 810 | M | 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-8 | 5/16/2016 | 316 | 739 | F | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-9 | 5/16/2016 | 344 | 526 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-10 | 5/16/2016 | 342 | 556 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-11 | 5/16/2016 | 354 | 774 | F | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-12 | 5/16/2016 | 365 | 557 | M | 9 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-13 | 5/16/2016 | 388 | 729 | F | 7 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-14 | 5/16/2016 | 312 | 410 | M | ND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-15 | 5/16/2016 | 333 | 582 | M | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-16 | 5/16/2016 | 360 | 635 | M | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | papilloma | 0 | 1 | 1 | 0 |
| ASH16-17 | 5/16/2016 | 342 | 574 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-18 | 5/16/2016 | 285 | 313 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-19 | 5/16/2016 | 318 | 442 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-20 | 5/16/2016 | 360 | 680 | F | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-21 | 5/16/2016 | 260 | 210 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-22 | 5/16/2016 | 350 | 489 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-23 | 5/16/2016 | 302 | 388 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-24 | 5/16/2016 | 364 | 857 | M | ND | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-25 | 5/16/2016 | 328 | 550 | M | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-26 | 5/16/2016 | 305 | 354 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-27 | 5/16/2016 | 352 | 656 | F | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-28 | 5/16/2016 | 364 | 716 | F | 11 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | CO |
| ASH16-29 | 5/16/2016 | 340 | 515 | F | 7 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | papilloma | 0 | 0 | 1 | 0 |

**Table 4.** Morphometric data, visible and microscopic abnormalities: Ashtabula River, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body, and barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| ASH16-30 | 5/16/2016 | 274 | 257 | M | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-31 | 5/16/2016 | 287 | 316 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-32 | 5/16/2016 | 354 | 693 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-33 | 5/16/2016 | 418 | 181 | M | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | osteoma | 1 | 0 | 0 |
| ASH16-34 | 5/16/2016 | 365 | 589 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-35 | 5/16/2016 | 300 | 391 | F | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-36 | 5/16/2016 | 341 | 532 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-37 | 5/16/2016 | 290 | 339 | F | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-38 | 5/16/2016 | 374 | 750 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-39 | 5/16/2016 | 358 | 703 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-40 | 5/16/2016 | 368 | 586 | M | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | CO |
| ASH16-41 | 5/16/2016 | 320 | 398 | F | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-42 | 5/16/2016 | 311 | 410 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-43 | 5/16/2016 | 293 | 317 | M | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| ASH16-44 | 5/16/2016 | 330 | 581 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-45 | 5/16/2016 | 325 | 471 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-46 | 5/16/2016 | 336 | 544 | F | ND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-47 | 5/18/2016 | 272 | 261 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-48 | 5/18/2016 | 381 | 809 | M | 8 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-49 | 5/18/2016 | 371 | 696 | M | 6 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-50 | 5/18/2016 | 353 | 465 | M | 9 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-51 | 5/18/2016 | 277 | 339 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-52 | 5/18/2016 | 367 | 669 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-53 | 5/18/2016 | 298 | 354 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-54 | 5/18/2016 | 325 | 457 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-55 | 5/18/2016 | 332 | 430 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-56 | 5/18/2016 | 319 | 473 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-57 | 5/18/2016 | 356 | 440 | F | 12 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | melanoma | 0 | 1 | 1 | 0 |
| ASH16-58 | 5/18/2016 | 365 | 751 | M | 11 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | papilloma | 0 | 1 | 1 | 0 |

**Table 4.** Morphometric data, visible and microscopic abnormalities: Ashtabula River, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body, and barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| ASH16-59 | 5/18/2016 | 346 | 629 | M | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| ASH16-60 | 5/18/2016 | 355 | 448 | M | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | CO |
| ASH16-61 | 5/18/2016 | 351 | 660 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | osteoma | 0 | 0 | 0 |
| ASH16-62 | 5/18/2016 | 332 | 590 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-63 | 5/18/2016 | 334 | 468 | M | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | SCC | 0 | 1 | 1 | 0 |
| ASH16-64 | 5/18/2016 | 340 | 601 | F | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-65 | 5/18/2016 | 245 | 169 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-66 | 5/18/2016 | 332 | 735 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| ASH16-67 | 5/18/2016 | 305 | 460 | F | 7 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-68 | 5/18/2016 | 338 | 557 | M | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | osteoma | 0 | 1 | 0 |
| ASH16-69 | 5/18/2016 | 351 | 704 | F | 11 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | papilloma | osteoma | 0 | 1 | CO, HCC |
| ASH16-70 | 5/18/2016 | 348 | 601 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-71 | 5/18/2016 | 322 | 430 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-72 | 5/18/2016 | 354 | 628 | F | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 1 | 0 |
| ASH16-73 | 5/18/2016 | 354 | 522 | M | 9 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-74 | 5/18/2016 | 387 | 866 | M | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | SCC | 0 | 1 | 0 | 0 |
| ASH16-75 | 5/18/2016 | 296 | 396 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-76 | 5/18/2016 | 399 | 955 | F | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-77 | 5/18/2016 | 357 | 630 | F | 10 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | osteoma | osteoma | 0 | 1 | 0 |
| ASH16-78 | 5/18/2016 | 370 | 584 | M | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| ASH16-79 | 5/18/2016 | 361 | 740 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-80 | 5/18/2016 | 372 | 761 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| ASH16-81 | 5/18/2016 | 361 | 760 | M | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-82 | 5/18/2016 | 321 | 471 | M | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | SCC | 0 | 1 | 1 | 0 |
| ASH16-83 | 5/18/2016 | 340 | 441 | M | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-84 | 5/18/2016 | 351 | 590 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-85 | 5/18/2016 | 387 | 878 | M | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-86 | 5/18/2016 | 316 | 435 | F | 15 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | papilloma | 0 | 1 | 1 | HA |
| ASH16-87 | 5/18/2016 | 296 | 297 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

**Table 4.** Morphometric data, visible and microscopic abnormalities: Ashtabula River, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body, and barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| ASH16-88 | 5/18/2016 | 336 | 564 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-89 | 5/18/2016 | 271 | 253 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-90 | 5/18/2016 | 311 | 456 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-91 | 5/18/2016 | 341 | 550 | F | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | HCC |
| ASH16-92 | 5/18/2016 | 360 | 637 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-93 | 5/18/2016 | 355 | 520 | F | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-94 | 5/18/2016 | 328 | 531 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-95 | 5/18/2016 | 341 | 514 | M | 11 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 1 | 0 |
| ASH16-96 | 5/18/2016 | 340 | 538 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-97 | 5/18/2016 | 346 | 548 | M | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-98 | 5/18/2016 | 371 | 751 | M | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-99 | 5/18/2016 | 345 | 598 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-100 | 5/18/2016 | 341 | 624 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-101 | 5/18/2016 | 398 | 862 | M | 11 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | papilloma | 0 | 0 | 0 | CO |
| ASH16-102 | 5/18/2016 | 362 | 719 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | osteoma | 1 | 0 | 0 |
| ASH16-103 | 5/18/2016 | 344 | 667 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-104 | 5/18/2016 | 327 | 536 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-105 | 5/18/2016 | 321 | 495 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-106 | 5/18/2016 | 330 | 553 | F | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-107 | 5/18/2016 | 341 | 541 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| ASH16-108 | 5/18/2016 | 363 | 675 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-109 | 5/18/2016 | 332 | 608 | F | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | osteoma | 0 | 0 | 0 |
| ASH16-110 | 5/18/2016 | 294 | 341 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-111 | 5/18/2016 | 331 | 511 | F | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-112 | 5/18/2016 | 345 | 590 | M | 5 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-113 | 5/18/2016 | 367 | 527 | M | 11 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma, melanoma | 0 | 1 | 0 | 0 |
| ASH16-114 | 5/18/2016 | 351 | 549 | M | 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-115 | 5/18/2016 | 342 | 496 | F | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4.** Morphometric data, visible and microscopic abnormalities: Ashtabula River, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body, and barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| ASH16-116 | 5/18/2016 | 285 | 434 | F | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-117 | 5/18/2016 | 331 | 526 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| ASH16-118 | 5/18/2016 | 311 | 377 | M | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| ASH16-119 | 5/18/2016 | 337 | 594 | F | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-120 | 5/18/2016 | 312 | 437 | F | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-121 | 5/18/2016 | 319 | 426 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-122 | 5/18/2016 | 380 | 756 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-123 | 5/18/2016 | 348 | 601 | F | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-124 | 5/18/2016 | 353 | 645 | M | ND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-125 | 5/18/2016 | 375 | 782 | M | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-126 | 5/18/2016 | 319 | 405 | F | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-127 | 5/18/2016 | 356 | 619 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| ASH16-128 | 5/18/2016 | 321 | 574 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-129 | 5/18/2016 | 325 | 548 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-130 | 5/18/2016 | 368 | 669 | F | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | osteoma | 0 | 0 | 0 |
| ASH16-131 | 5/18/2016 | 334 | 513 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-132 | 5/18/2016 | 341 | 539 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-133 | 5/18/2016 | 310 | 363 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-134 | 5/18/2016 | 355 | 556 | M | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-135 | 5/18/2016 | 331 | 525 | M | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | osteoma | 0 | 0 | 0 |
| ASH16-136 | 5/18/2016 | 339 | 562 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-137 | 5/18/2016 | 268 | 227 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-138 | 5/18/2016 | 336 | 610 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | HCC |
| ASH16-139 | 5/18/2016 | 325 | 415 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-140 | 5/18/2016 | 349 | 670 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-141 | 5/18/2016 | 368 | 698 | M | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-142 | 5/18/2016 | 336 | 607 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | osteoma | 1 | 1 | 0 |
| ASH16-143 | 5/18/2016 | 347 | 598 | F | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-144 | 5/18/2016 | 350 | 669 | F | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4.** Morphometric data, visible and microscopic abnormalities: Ashtabula River, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body, and barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| ASH16-145 | 5/18/2016 | 332 | 515 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ASH16-146 | 5/18/2016 | 331 | 520 | M | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| ASH16-147 | 5/18/2016 | 341 | 444 | M | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | CO |
| ASH16-148 | 5/18/2016 | 311 | 445 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-149 | 5/18/2016 | 350 | 650 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ASH16-150 | 5/18/2016 | 352 | 655 | M | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |

**Table 5.** Morphometric data, visible and microscopic abnormalities: Conneaut Creek, Ohio, May 2016.

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body surface, barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| CON16-1 | 5/17/2016 | 370 | 694 | M | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-2 | 5/17/2016 | 383 | 823 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-3 | 5/17/2016 | 311 | 442 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-4 | 5/17/2016 | 391 | 926 | M | ND | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 1 | 0 |
| CON16-5 | 5/17/2016 | 346 | 652 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-6 | 5/17/2016 | 355 | 652 | F | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-7 | 5/17/2016 | 376 | 714 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-8 | 5/17/2016 | 359 | 754 | ND | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-9 | 5/17/2016 | 371 | 642 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-10 | 5/17/2016 | 349 | 596 | M | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-11 | 5/17/2016 | 331 | 394 | F | 8 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | osteoma | 0 | 0 | 0 |
| CON16-12 | 5/17/2016 | 342 | 586 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-13 | 5/17/2016 | 357 | 744 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-14 | 5/17/2016 | 371 | 691 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-15 | 5/17/2016 | 382 | 791 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | CC,HC |
| CON16-16 | 5/17/2016 | 354 | 714 | F | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-17 | 5/17/2016 | 344 | 470 | F | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| CON16-18 | 5/17/2016 | 388 | 960 | M | 9 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | papilloma | osteoma | 1 | 0 | 0 |
| CON16-19 | 5/17/2016 | 360 | 756 | M | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-20 | 5/17/2016 | 355 | 697 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-21 | 5/17/2016 | 395 | 939 | M | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-22 | 5/17/2016 | 324 | 506 | M | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-23 | 5/17/2016 | 373 | 629 | M | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-24 | 5/17/2016 | 360 | 684 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-25 | 5/17/2016 | 355 | 619 | M | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-26 | 5/17/2016 | 346 | 574 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-27 | 5/17/2016 | 344 | 549 | M | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-28 | 5/17/2016 | 333 | 582 | F | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | papilloma | 0 | 0 | 0 | 0 |
| CON16-29 | 5/17/2016 | 325 | 370 | F | 10 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

**Table 5.** Morphometric data, visible and microscopic abnormalities: Conneaut Creek, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body surface, barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| CON16-30 | 5/17/2016 | 339 | 528 | M | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-31 | 5/17/2016 | 320 | 542 | F | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-32 | 5/17/2016 | 315 | 314 | F | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-33 | 5/17/2016 | 359 | 618 | F | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-34 | 5/17/2016 | 326 | 562 | F | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-35 | 5/17/2016 | 360 | 693 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-36 | 5/17/2016 | 354 | 656 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-37 | 5/17/2016 | 335 | 529 | F | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-38 | 5/17/2016 | 388 | 768 | M | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-39 | 5/17/2016 | 363 | 766 | F | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-40 | 5/17/2016 | 343 | 584 | M | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-41 | 5/17/2016 | 354 | 648 | F | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-42 | 5/17/2016 | 385 | 685 | M | 11 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | CO |
| CON16-43 | 5/17/2016 | 361 | 654 | M | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-44 | 5/17/2016 | 365 | 715 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-45 | 5/17/2016 | 386 | 902 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-46 | 5/17/2016 | 326 | 469 | F | ND | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| CON16-47 | 5/17/2016 | 366 | 736 | M | ND | 0 | 1 | 0 | 0 | 1 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-48 | 5/17/2016 | 304 | 407 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-49 | 5/17/2016 | 345 | 525 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-50 | 5/17/2016 | 329 | 544 | F | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-51 | 5/17/2016 | 350 | 647 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| CON16-52 | 5/17/2016 | 325 | 477 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-53 | 5/17/2016 | 324 | 624 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-54 | 5/17/2016 | 386 | 805 | F | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-55 | 5/17/2016 | 351 | 529 | M | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-56 | 5/17/2016 | 346 | 575 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-57 | 5/17/2016 | 386 | 807 | M | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-58 | 5/17/2016 | 326 | 369 | F | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 5.** Morphometric data, visible and microscopic abnormalities: Conneaut Creek, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body surface, barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| CON16-59 | 5/17/2016 | 369 | 778 | M | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-60 | 5/17/2016 | 325 | 482 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-61 | 5/17/2016 | 315 | 464 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-62 | 5/17/2016 | 370 | 849 | M | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-63 | 5/17/2016 | 345 | 670 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-64 | 5/17/2016 | 374 | 647 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-65 | 5/17/2016 | 370 | 697 | M | 6 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-66 | 5/17/2016 | 366 | 785 | F | 9 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-67 | 5/17/2016 | 305 | 485 | F | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | CO |
| CON16-68 | 5/17/2016 | 345 | 564 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CON16-69 | 5/17/2016 | 345 | 734 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-70 | 5/17/2016 | 285 | 304 | F | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-71 | 5/17/2016 | 300 | 399 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-72 | 5/17/2016 | 363 | 641 | M | 8 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-73 | 5/17/2016 | 320 | 483 | F | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-74 | 5/17/2016 | 325 | 579 | F | 8 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-75 | 5/17/2016 | 315 | 435 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-76 | 5/18/2016 | 332 | 570 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-77 | 5/18/2016 | 381 | 815 | F | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-78 | 5/18/2016 | 299 | 377 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-79 | 5/18/2016 | 352 | 565 | M | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-80 | 5/18/2016 | 340 | 510 | M | ND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-81 | 5/18/2016 | 326 | 502 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-82 | 5/18/2016 | 275 | 298 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-83 | 5/18/2016 | 305 | 419 | F | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-84 | 5/18/2016 | 296 | 352 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-85 | 5/18/2016 | 341 | 610 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-86 | 5/18/2016 | 372 | 766 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-87 | 5/18/2016 | 327 | 467 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 5.** Morphometric data, visible and microscopic abnormalities: Conneaut Creek, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body surface, barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| CON16-88 | 5/18/2016 | 280 | 326 | F | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-89 | 5/18/2016 | 298 | 404 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| CON16-90 | 5/18/2016 | 357 | 732 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-91 | 5/18/2016 | 378 | 806 | F | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-92 | 5/18/2016 | 320 | 467 | F | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-93 | 5/18/2016 | 355 | 688 | M | 10 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-94 | 5/18/2016 | 320 | 467 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-95 | 5/18/2016 | 315 | 355 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-96 | 5/18/2016 | 335 | 590 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-97 | 5/18/2016 | 383 | 747 | F | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | HA |
| CON16-98 | 5/18/2016 | 320 | 525 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-99 | 5/18/2016 | 351 | 649 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-100 | 5/18/2016 | 391 | 971 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-101 | 5/19/2016 | 382 | 755 | M | 10 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 1 | CC |
| CON16-102 | 5/19/2016 | 362 | 553 | M | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-103 | 5/19/2016 | 331 | 593 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-104 | 5/19/2016 | 339 | 517 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-105 | 5/19/2016 | 340 | 507 | M | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-106 | 5/19/2016 | 420 | 917 | M | 10 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | papilloma | osteoma | 0 | 0 | 0 |
| CON16-107 | 5/19/2016 | 314 | 415 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-108 | 5/19/2016 | 335 | 556 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-109 | 5/19/2016 | 355 | 576 | F | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-110 | 5/19/2016 | 341 | 514 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-111 | 5/19/2016 | 332 | 515 | F | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-112 | 5/19/2016 | 350 | 600 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-113 | 5/19/2016 | 370 | 660 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-114 | 5/19/2016 | 368 | 767 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-115 | 5/19/2016 | 370 | 718 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-116 | 5/19/2016 | 313 | 440 | F | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 5.** Morphometric data, visible and microscopic abnormalities: Conneaut Creek, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body surface, barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| CON16-117 | 5/19/2016 | 368 | 791 | F | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-118 | 5/19/2016 | 329 | 570 | M | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-119 | 5/19/2016 | 287 | 333 | F | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-120 | 5/19/2016 | 351 | 556 | M | 5 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-121 | 5/19/2016 | 358 | 670 | M | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-122 | 5/19/2016 | 313 | 435 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-123 | 5/19/2016 | 371 | 678 | F | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-124 | 5/19/2016 | 365 | 665 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-125 | 5/19/2016 | 391 | 798 | M | 7 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | papilloma | 0 | 1 | 1 | 0 |
| CON16-126 | 5/19/2016 | 371 | 753 | M | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 1 | 0 |
| CON16-127 | 5/19/2016 | 364 | 718 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-128 | 5/19/2016 | 354 | 598 | M | 5 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-129 | 5/19/2016 | 372 | 700 | M | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 1 | 0 | 0 |
| CON16-130 | 5/19/2016 | 346 | 639 | M | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-131 | 5/19/2016 | 376 | 782 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-132 | 5/19/2016 | 364 | 647 | M | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-133 | 5/19/2016 | 342 | 528 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-134 | 5/19/2016 | 331 | 556 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-135 | 5/19/2016 | 322 | 442 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-136 | 5/19/2016 | 304 | 368 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-137 | 5/19/2016 | 321 | 411 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CON16-138 | 5/19/2016 | 357 | 606 | M | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | CC |
| CON16-139 | 5/19/2016 | 345 | 631 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-140 | 5/19/2016 | 360 | 720 | M | 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-141 | 5/19/2016 | 384 | 978 | ND | 11 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | CO |
| CON16-142 | 5/19/2016 | 329 | 429 | M | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-143 | 5/19/2016 | 255 | 208 | F | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-144 | 5/19/2016 | 300 | 370 | F | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | papilloma | 0 | 0 | 0 | 0 |
| CON16-145 | 5/19/2016 | 323 | 510 | F | ND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 5.** Morphometric data, visible and microscopic abnormalities: Conneaut Creek, Ohio, May 2016.—Continued

[mm, millimeters; F, female; M, male; ND, not determined; 1, present; 0, absent; SCC, squamous cell carcinoma; CO, cholangioma; CC, cholangiocarcinoma; HA, hepatic cell adenoma; HCC, hepatic cell carinoma]

| Fish number | Collection date | Length (mm) | Weight (grams) | Sex | Age | Lip and body surface lesions | | | Barbel abnormalities | | | | Lip, body surface, barbel neoplasms | Other neoplasms | Liver pathology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Red/ eroded areas | Raised lesions | Melanistic areas | Missing | Short | Deformed | Knobbed | | | Bile duct proliferation | Foci of cell alteration | Neoplasms |
| CON16-146 | 5/19/2016 | 295 | 362 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-147 | 5/19/2016 | 339 | 549 | M | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| CON16-148 | 5/19/2016 | 347 | 592 | M | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-149 | 5/19/2016 | 362 | 731 | F | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CON16-150 | 5/19/2016 | 363 | 640 | M | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

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