STATE OF MICHIGAN
DEPARTMENT OF HEALTH AND HUMAN SERVICES
LANSING

GRETCHEN WHITMER
GOVERNOR

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MEMORANDUM

DATE: December 8, 2019

TO: Deb MacKenzie-Taylor, Ph.D., Toxicology & Response Section Manager

FROM: Gary Klase, MS, Toxicologist, Division of Environmental Health
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SUBJECT: Public Health Advisory for Wildlife from Clark's Marsh

The purpose of this memo is to evaluate available information to determine if a presumptive "Do Not Eat" public health advisory should be issued for all resident aquatic and semi-aquatic wildlife from Clark's Marsh in Oscoda, Iosco County, Michigan.

Clark's Marsh is situated between the Au Sable River and the former Wurtsmith Air Force Base (WAFB) in Oscoda Township, Iosco County, Michigan. WAFB occupied approximately 5,223 acres and operated from 1924 until 1993. The historical use of aqueous film-forming foams (AFFF) containing per- and polyfluoroalkyl substances (PFAS) at WAFB has caused extensive PFAS contamination of the surrounding area, including groundwater and surface water.

High levels of PFAS measured in various animal receptors has led to the issuance of "Do Not Eat" consumption advisories for fish and deer in and around Clark's Marsh. The extensive contamination of the marsh, prior consumption advisories for fish and deer, and high PFAS levels reported in other animal species have raised questions about whether public health advisories are needed for additional species of wildlife in Clark's Marsh.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE, formerly known as the Michigan Department of Environmental Quality or MDEQ) and others have documented extensive contamination by perfluorooctane sulfonate (PFOS) and other PFAS in the area surrounding Clark's Marsh. This includes PFAS that have leached through the sandy soil into the groundwater and migrated into the surface water and sediments in the ponds at Clark's Marsh. PFAS have also been found in other nearby water bodies, including Van Etten Lake, the Au Sable River, and Allen Lake.[1]

[1] Michigan Department of Environmental Quality. 2017. Addendum for Per- and Polyfluoroalkyl Substances (PFAS) in Michigan: Current State of Knowledge and Recommendations for Future Actions, Appendix A. https://www.michigan.gov/documents/deq/deq-aqd-tox_pfas_white_paper_addendum_final_612789_7.pdf

The concentrations of PFAS in the surface water samples collected from Clark's Marsh are shown in Table 1.[2]

Table 1. Geometric mean concentrations in nanograms per liter (ng/L) or parts per trillion (ppt) of PFAS in surface water samples collected from Clark's Marsh in 2011 and 2013.

PFAS	Geometric mean in ng/L
Perfluorobutanoic acid (PFBA)	116
Perfluorobutane sulfonate (PFBS)	104
Perfluoropentanoic acid (PFPeA)	418
Perfluorohexanoic acid (PFHxA)	922
Perfluorohexane sulfonate (PFHxS)	3,756
Perfluoroheptanoic acid (PFHpA)	173
Perfluoroheptanesulfonate (PFHpS)	171
Perfluorooctanoic acid (PFOA)	1,309
Perfluorooctane sulfonate (PFOS)	5,099
Perfluorooctane sulfonamide (PFOSA)	172
Perfluorononanoic acid (PFNA)	24.2
Perfluorodecanoic acid (PFDA)	2.5

EGLE's Rule 57 Human Noncancer Value (HNV) of 12 ng/L for PFOS represents the water-column concentration above which bioaccumulation in fish tissue may present a human health concern for consumers of fish. The geometric mean PFOS concentration in Clark's Marsh surface water exceeded the HNV by a factor of more than 400, suggesting that consumption of fish (and possibly other biota) from Clark's Marsh is likely to present a human health risk.

In 2012, the Michigan Department of Health and Human Services (MDHHS) issued a "Do Not Eat" public health advisory for fish from Clark's Marsh due to PFOS contamination from the former WAFB. The arithmetic mean concentration of PFOS measured in fish filets (Bluegill and Pumpkinseed, n=19) from Clark's Marsh was 5,498 ng/g, and ranged from 334 ng/g to 9,580 ng/g.[3] PFOS exceeded Michigan's "Do Not Eat" threshold of 300 ng/g in all samples and by as much as a factor of 32 times for the most-contaminated samples.

Further lines of evidence show widespread PFOS contamination in biota from Clark's Marsh, including:

[2] Michigan Department of Community Health. 2015. Michigan Department of Community Health Final Report USEPA-Great Lakes Restoration Initiative Project. May 28, 2015. https://www.michigan.gov/documents/mdch/MDCH_GL-00E01122-0_Final_Report_493494_7.pdf

[3] Michigan Department of Health and Human Services. 2017. Health Consultation. Perfluorooctane Sulfonate (PFOS) in Fish. Former Wurtsmith Air Force Base Oscoda, Iosco County, Michigan EPA Facility ID: MI5570024278. February 14, 2017. https://www.michigan.gov/documents/mdhhs/WAFB_Fish_HC__Final__2-14-2017_552188_7.pdf

- Muskrats in Clark's Marsh are exposed to and contaminated by PFAS. These semi-aquatic mammals spend much of their time in the water and primarily consume aquatic plants, providing two potential routes of exposure to PFOS in Clark's Marsh.[4] Based on preliminary data collected in 2014 and 2015, the average concentration of PFOS in the muscle tissue from two Clark's Marsh muskrat was 66 ng/g. The average concentrations of PFOS in the liver and kidney were 1,623 ng/g and 1,524 ng/g respectively. Two samples are not sufficient to adequately assess a species for a consumption advisory. However, this data, in tandem with the white-tailed deer data, indicate that at least some mammals in Clark's Marsh are exposed to, and accumulating PFOS.

- PFAS levels in tree swallows nesting at the Clark's Marsh area were studied from 2014 to 2017. Tree swallows are used as an indicator species for contamination in the aquatic food web because they feed on the aerial stage of benthic aquatic invertebrates and reflect contaminants that are bioavailable in the benthic food web. Tree swallows feed within half a kilometer of their nest boxes and so reflect contamination from a localized area. Egg, plasma, liver, brain, and diet (stomach contents) were evaluated for PFAS contamination. The geometric mean concentrations of PFOS were 662 ng/g in the egg (n =40), 856 ng/mL in the plasma (n=20), 209 ng/g in the liver (n=10), 142 ng/g in the brain (n=10) and 138 ng/g in the diet (n=6). The Clark's Marsh PFOS levels found in eggs and plasma greatly exceed levels found at 69 other sites in the Great Lakes region, suggesting that the aquatic food web at Clark's Marsh is among the most highly contaminated in the region.[5]

- In the fall of 2018, MDHHS and the Michigan Department of Natural Resources (DNR) issued a "Do Not Eat" advisory for white-tailed deer taken from within a 5-mile radius of Clark's Marsh. The advisory was issued out of an abundance of caution due to high levels of PFOS found in muscle and organs of one (1) deer out of 20 taken in the Oscoda area. The concentration of PFOS in muscle from the contaminated deer was 547 ng/g, almost twice the 300 ng/g "Do Not Eat" threshold for PFOS. The PFOS concentrations in the kidney and liver of the same deer were about 12 and 20 times higher than the "Do Not Eat" threshold respectively. The other 19 deer from the Oscoda area had no or low levels of PFOS detected. It is unknown if the primary route of exposure for this deer was direct (by drinking contaminated water) or indirect (by eating vegetation growing in or near contaminated water).[6]

- A research team from Purdue University investigated PFAS accumulation and distribution in the aquatic food web in Clark's Marsh and presented preliminary findings to the Michigan PFAS Action Response Team (MPART) Wildlife Work Group on June 24, 2019. Sediment, algae, snails, tadpoles, dragonflies, crayfish, central mudminnows, and brook sticklebacks were collected in 2018 and analyzed for PFAS. The mean concentration of PFOS in each fish species was greater than 300 ng/g while lower levels of tissue PFOS concentrations were seen in algae (31 ng/g), snails (24 ng/g),

[4] USEPA. 1993. Wildlife Exposure Factors Handbook, Volume I. EPA/600/R-93/187.

[5] Custer CM, Custer TW, Delaney R, Dummer PM, Schultz S, Karouna-Renier N. 2019. Perfluoroalkyl Contaminant Exposure and Effects in Tree Swallows Nesting at Clarks Marsh, Oscoda, Michigan, USA. Arch Environ Contam Toxicol. 77(1):1-13. PubMed PMID: 30955057.

[6] Michigan Department of Health and Human Services. 2018. PFAS levels in Michigan Deer and Eat Safe Wild Game Guidelines. https://www.michigan.gov/documents/pfasresponse/2019-01-11_MDHHS_deer_technical_report_644330_7.pdf

tadpoles (24 ng/g), dragonflies (65 ng/g), and crayfish (45 ng/g),[7] demonstrating PFOS contamination across a range of aquatic taxa, including mollusks, arthropods, and amphibians.

Based on these multiple lines of evidence, it is apparent that the Clark's Marsh ecosystem is highly contaminated with PFAS, especially PFOS. This contamination exists throughout the water column, sediment, and in multiple taxa of biota, including fish, mammals, mollusks, arthropods, and amphibians. Tree swallow data is not evaluated for consumption purposes, but data from this indicator species demonstrates that the Clark's Marsh aquatic food web is contaminated beyond what has been seen at many other sites in the Great Lakes region, including sites of known PFOS contamination. Finally, the white-tailed deer data show that contamination may not be consistent among individuals within a species but that some individuals may present a human health risk to the consumer. This type of species contamination necessitates large sample sizes to adequately characterize each species, especially given that routes of exposure and uptake of PFOS are often poorly understood.

Further investigation of Clark's Marsh for wildlife consumption concerns is recommended. Concern has been raised that harvesting large samples of multiple taxa would prove difficult and may also negatively impact the target populations of biota. The DNR is currently working with researchers to further study contaminant sources, contaminated media, exposure pathways, and endpoint receptors within Clark's Marsh and the surrounding ecosystem. The DNR will use this information to target key fish and wildlife for further PFAS sampling. Waterfowl in particular are currently being investigated for potential PFOS contamination, as it is unclear how these transient populations of birds may be affected by localized sources of contamination such as Clark's Marsh.

Therefore, while continued investigation of PFAS contamination of Clark's Marsh is warranted and ongoing, lines of evidence currently exist showing widespread PFOS contamination in Clark's Marsh biota across numerous and diverse taxa. These lines of evidence indicate that a precautionary "Do Not Eat" public health advisory is appropriate for all resident aquatic and semi-aquatic wildlife taken from the Marsh at this time. This includes fish, aquatic and semi-aquatic mammals (including muskrats), amphibians (including frogs), mollusks (including snails), reptiles (including turtles), and arthropods (including crayfish).

[7] Robert Flynn, personal communication, September 5, 2019