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EM-17

Laboratory Report
Analysis of Fluorochemicals in Wild Bird Livers

Laboratory Report No. FACT-GEN-010

LR U2392

Testing Laboratory

3M Environmental Technology & Safety Services
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Requester

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1 Introduction

Sixty liver samples collected from various species of birds were characterized with respect to specific fluorochemicals. The birds were classified according to specie and geographic location. Six species of birds are represented in this study, including Sandhill Cranes, Double-Crested Cormorants, White Pelicans, Brown Pelicans, Great Blue Herons, and Brandt's Cormorants. The birds were found at a variety of sites across the United States including Nebraska, New Mexico, Florida, Arizona, California, Louisiana, and Florida. In general, the cause of death to these birds is unknown. Details about the location each bird was found and about the cause of death (if known) are included in Appendix C of this report.

Liver samples were homogenized and extracted using an ion-pairing extraction procedure. The extracts were quantitatively analyzed for PFOS and PFOSA using high-pressure liquid chromatography/electrospray tandem mass spectrometry (HPLC/ESMSMS), and evaluated versus a standard curve extracted from rabbit liver. Analytical details are available in the study binder maintained by FACT in the 3M Environmental Lab. The presence or absence of other known fluorochemical contaminants and metabolites (PFOSAA, M556, M570, POAA, M513, PFHS, and PFDS) was determined by inspection of HPLC/ESMSMS analysis of 2 bird livers within each group. A full list of acronyms is attached in Appendix B.

With the exception of most of the Sandhill Cranes and a single Brown Pelican from California, the extracts from the livers of all of the birds were determined to contain PFOS above the method limit of quantitation (MDL = 10 ppb). Extracts from the livers of three of 15 Sandhill Cranes showed some PFOS; two of these extracts contained PFOS levels very near the MDL.

Extracts from one Brandt's Cormorant from San Diego, CA and one White Pelican, from Calipatria, CA showed PFOS levels in great excess of those determined in the extracts from other birds within the same classification (>20x for the cormorant and nearly 10x for the pelican). If these two outlying points are removed and PFOS levels within a particular classification are averaged, some general observations based on the geographical location of the birds' habitat can be made.

With the exception of the Sandhill Cranes, in general, liver from birds collected from the western US (San Diego, CA, Calipatria, CA,) show relatively low levels of PFOS, with an average of less than 50 ppb. Livers from birds collected on the East Coast of the US (Miami, Naples, and Ft. Lauderdale, FL) show moderate PFOS levels, approximately 105 ppb. Extracts from bird livers collected from the Central US (LA and NV) were determined to contain the highest levels of PFOS, approximately 300 ppb.

It is unlikely that the differences associated with PFOS levels in the livers are purely a function of species. In more than one instance, the same species of bird living in a different environment showed significantly different PFOS levels. For example, livers collected from white pelicans in California were determined to contain an average PFOS concentration of 58 ppb, while livers collected from White Pelicans in Nevada showed average PFOS levels of over 350 ppb. Sandhill Cranes are an exception to this observation, as the livers from these birds were determined to be uniformly low in PFOS, regardless of the geographic location of the birds.

With the exception of the Sandhill Cranes, liver extracts from at least one of the two birds screened within each classification were determined to contain PFDS. Liver extracts from several species, including 1 Sandhill Crane, were determined to contain a small amount of PFHS. Nearly 20% of the liver extracts were determined to contain a small amount of PFOSA. No POAA, M513, M556, M570, or PFOSAA was detected in the liver extracts from any of the birds. Appendix A contains these results.

This data indicates that potential geographic trends associated with the environmental distribution of PFOS and other fluorochemicals may be traceable by characterization of low-level of these compounds in animal tissue samples.

Although rigorous quality control measures and 3M Environmental Laboratory Standard Operating Procedures were followed, the acquisition of this data was not necessarily collected according to applicable Good Laboratory Practices. This data is not suitable for distribution to any government agency in defense of product suitability or safety. Results should be considered to be semi-quantitative. Data presented here is the highest quality data available at this time.

2 Sample Receipt

On 5/5/98, Jean Burris from 3M Occupational Medicine delivered the bird liver samples to the Environmental Lab; samples were received frozen. The samples were originally sent to Geary Olsen (3M Occupational Medicine) by Scott P. Hansen of the National Wildlife Health Center in Madison, Wisconsin.

3 Holding Times

There is no holding time criteria associated with these samples for LC/ESMSMS analysis.

4 Methods - Analytical and Preparatory

Analytical methods

FACT-M-1.0, Extraction of Potassium Perfluorooctanesulfonate or Other Anionic Fluorochemical Surfactants from Liver for Analysis Using HPLC/ESMS

FACT-M-2.0, Analysis of Fluorochemicals in Liver Extract Using HPLC-Electrospray/Mass Spectrometry

Sample preparation - aqueous samples, HPLC/ESMSMS: ion-pairing extraction

Analyte is extracted from a sample matrix with ion pairing reagent [tetrabutyl ammonium hydrogen sulfate (TBA)] in a pH-controlled environment. The cationic reagent selectively targets anionic fluorochemicals. Once the anion-TBA pair is formed, the analyte is transferred into a non-polar organic solvent (ethyl acetate), dried, and reconstituted in methanol for MS analysis.

HPLC/ESMS and HPLC/ESMSMS: for detailed qualitative work

In HPLC, an aliquot of extract is injected and passed through a reverse phase liquid chromatographic column. Based on the affinity of the analyte for the stationary phase in the column relative to the liquid mobile phase, the analyte is retained for a characteristic amount of time. For example, in a standard solution PFOS may elute at 8.0 minutes. Retention times between a standard PFOS solution and the analyte extracted from liver in this analysis were matched on the HPLC system to within 1%.

Following HPLC separation, ESMSMS provides a rapid and accurate means for analyzing a wide range of organic compounds, including fluorochemicals. Electrospray, an ionization technique used primarily for detection of molecular ions, is generally operated at relatively mild temperatures. Molecules are ionized, and a primary ion, characteristic of the analyte, is selected. This ion is bombarded with high-energy gas; subsequent collisions create smaller secondary ionic fragments unique to the primary ion, which are detected.

For example, for PFOS ($C_8F_{17}SO_3$) analysis, ion 499 is selected as the characteristic primary ion. This ion is fragmented into other ions such as 80 amu (corresponding to SO_3), and 230 amu ($C_3F_6SO_3$). Each of these secondary fragments is detected and can be used to differentiate PFOS from other compounds that might have the same characteristic 499 amu primary ion, but different chemical compositions and secondary ion fragmentation patterns.

5 Analysis

5.1 Calibration

A mid-level, extracted matrix calibration check standard is analyzed every 5-10 samples to monitor instrumental drift. Calibration check standards are compliant if instrumental response is within +/- 30% of the expected value.

Quantitation of the target analytes is based on linear regression analysis, weighted 1/x, of two extracted matrix curves bracketing each group of samples. Quantitation of each analyte is based in the response of a specific daughter ion using the multiple response-monitoring mode of the instrument. The second curve was not used for PFOS determination; bracketing calibration checks were all compliant, so this exclusion does not adversely affect the data quality.

5.2 Blanks

Two extraction blanks, utilizing water as surrogate matrix, are extracted with each batch of samples. Additionally, two samples of blank matrix, used for the extracted calibration curves, are extracted along with each batch of samples and curves.

Blanks are compliant if no target analyte is detected above the limit of detection for a specific analyte. In this study, all blanks were compliant.

5.3 Surrogates

Tetra-hydro perfluorooctane sulfonate is used as a surrogate in this analysis. Surrogate response is monitored to confirm gross instrumental failure, if necessary.

5.4 Matrix Spikes

Duplicate matrix spike analyses utilizing all target analytes were prepared and analyzed from Sandhill crane liver. Recoveries of PFOS and PFOSA were within the acceptable range of 70-130%.

5.5 Laboratory Control Samples

Laboratory Control Samples are not a component of this study.

5.6 Sample Related Comments

Matrix spikes were prepared for a single specie of bird. It is assumed that spike recoveries would be similar for all species. No standard material for PFDS is available. Compound identification is based on reasonable retention time and reasonable daughter ion spectrum. Until standard material is available, identification of this analyte should be considered to be preliminary.

Quantitation for PFOS was conducted by monitoring the transition 499 → 99. Some positive interference was observed when monitoring the 499 → 80 transition in the bird liver matrix. Transition parameters for the other target analytes are listed below.

Table 1: Analyte Transitions for HPLC-ESMSMS Analysis

Compound	Primary Ion	Transition Monitored
PFOS	499	99
PFOSA	498	78
PFOSAA	584	169
M556	556	169
M570	570	169
POAA	413	169
M513	469	169
PFHS	399	99
PFDS	599	99

6 Data Summary

With the exception of most of the Sandhill Cranes and a single Brown Pelican from California, the extracts from the livers of all of the birds were determined to contain PFOS above the method limit of quantitation (MDL = 10 ppb). Extracts from the livers of three of 15 Sandhill Cranes showed some PFOS; two of these extracts contained PFOS levels very near the MDL.

Extracts from one Brandt's Cormorant from San Diego, CA and one White Pelican, from Calipatria, CA showed PFOS levels in great excess of those determined in the extracts from other birds within the same classification (>20x for the cormorant and nearly 10x for the pelican). If these two outlying points are removed and PFOS levels within a particular classification are averaged, some general observations based on the geographical location of the birds' habitat can be made.

With the exception of the Sandhill Cranes, in general, liver from birds collected from the western US (San Diego, CA, Calipatria, CA,) show relatively low levels of PFOS, with an average of less than 50 ppb. Livers from birds collected on the East Coast of the US (Miami, Naples, and Ft. Lauderdale, FL) show moderate PFOS levels, approximately 105 ppb. Extracts from bird livers collected from the Central US (LA and NV) were determined to contain the highest levels of PFOS, approximately 300 ppb.

It is unlikely that the differences associated with PFOS levels in the livers are purely a function of species. In more than one instance, the same species of bird living in a different environment showed significantly different PFOS levels. For example, livers collected from white pelicans in California were determined to contain an average PFOS concentration of 58 ppb, while livers collected from White Pelicans in Nevada showed average PFOS levels of over 350 ppb. Sandhill Cranes are an exception to this observation, as the livers from these birds were determined to be uniformly low in PFOS, regardless of the geographic location of the birds.

With the exception of the Sandhill Cranes, liver extracts from at least one of the two birds screened within each classification were determined to contain PFDS. Liver extracts from several species, including 1 Sandhill Crane, were determined to contain a small amount of PFHS. Nearly 20% of the liver extracts were determined to contain a small amount of PFOSA. No POAA, M513, M556, M570, or PFOSAA was detected in the liver extracts from any of the birds.

This data indicates that potential geographic trends associated with the environmental distribution of PFOS and other fluorochemicals may be traceable by characterization of low-level of these compounds in animal tissue samples.

This report reflects the most accurate data available at this time. All numbers should be considered to be semi-quantitative.

7 Conclusion

This data indicates that potential geographic trends associated with the environmental distribution of PFOS may be traceable by characterization of low-level fluorochemicals in animal tissue samples.

8 Data / Sample Retention

Samples and extracts will be retained for future evaluation, if necessary.

9 Attachments

- 9.1 Attachment A: Tables of Qualitative and Quantitative Results from the Analysis of Liver Samples
- 9.2 Attachment B: Definitions of Fluorochemical Acronyms
- 9.3 Attachment C: Sample description and sample receipt data
- 9.4 Attachment D: Extraction and Analytical data

10 Signatures


Harold Johnson, Analytical Chemist

4/28/99
Date


Kris Hansen, Ph.D., Principal Analytical Investigator

4/28/99
Date

Analysis of Wild Bird Livers.

= not detected NA = not analyzed x = detected LOQ = Limit of Quantitation

Sample No.	Species	Location	PFOS ppb	PFOSA ppb	PFHS	PFDS
1	Sandhill Crane	Kearney, NE	41	<LOQ	x	#
2	Sandhill Crane	Kearney, NE	<LOQ	<LOQ	NA	NA
3	Sandhill Crane	Kearney, NE	<LOQ	<LOQ	#	#
4	Sandhill Crane	Kearney, NE	<LOQ	<LOQ	NA	NA
5	Sandhill Crane	Kearney, NE	<LOQ	<LOQ	NA	NA
6	Sandhill Crane	Chochise Co., AZ	<LOQ	<LOQ	#	NA
7	Sandhill Crane	Chochise Co., AZ	<LOQ	<LOQ	#	NA
8	Sandhill Crane	Chochise Co., AZ	<LOQ	<LOQ	NA	NA
9	Sandhill Crane	Chochise Co., AZ	<LOQ	<LOQ	NA	NA
10	Sandhill Crane	Chochise Co., AZ	<LOQ	<LOQ	NA	NA
11	White Pelican	Calipatria, CA	35	<LOQ	x	x
12	White Pelican	Calipatria, CA	1293	<LOQ	x	x
13	White Pelican	Calipatria, CA	29	<LOQ	NA	NA
14	White Pelican	Calipatria, CA	15	<LOQ	NA	NA
15	White Pelican	Calipatria, CA	153	<LOQ	NA	NA
16	Brandt's Cormorant	San Diego, CA	53	80	#	x
17	Brandt's Cormorant	San Diego, CA	46	31	NA	NA
18	Brandt's Cormorant	San Diego, CA	46	34	NA	NA
19	Brandt's Cormorant	San Diego, CA	80	13	NA	NA
20	Brandt's Cormorant	San Diego, CA	2055	94	x	x
21	Dbl. Crested Cormorant	St. Martinville, LA	59	20	x	x
22	Dbl. Crested Cormorant	St. Martinville, LA	145	7	#	x
23	Dbl. Crested Cormorant	St. Martinville, LA	333	23	NA	NA
24	Dbl. Crested Cormorant	St. Martinville, LA	76	<LOQ	NA	NA
25	Dbl. Crested Cormorant	St. Martinville, LA	170	<LOQ	NA	NA
26	Brown Pelican	Miami, FL	106	58	#	x
27	Brown Pelican	Miami, FL	134	11	#	x
28	Brown Pelican	Miami, FL	125	10	NA	NA
29	Brown Pelican	Miami, FL	159	47	NA	NA
30	Brown Pelican	Miami, FL	48	11	NA	NA
31	Sandhill Crane	Valencia Co., NM	<LOQ	<LOQ	#	#
32	Sandhill Crane	Valencia Co., NM	<LOQ	<LOQ	#	#
33	Sandhill Crane	Socorro Co., NM	<LOQ	<LOQ	NA	NA
34	Sandhill Crane	Socorro Co., NM	<LOQ	<LOQ	NA	NA
35	Sandhill Crane	Valencia Co., NM	<LOQ	<LOQ	NA	NA
36	Dbl. Crested Cormorant	Naples, FL	212	9	#	x
37	Dbl. Crested Cormorant	Naples, FL	10	<LOQ	#	#
38	Dbl. Crested Cormorant	Naples, FL	52	<LOQ	NA	NA
39	Dbl. Crested Cormorant	Naples, FL	100	35	NA	NA
40	Dbl. Crested Cormorant	Naples, FL	152	24	NA	NA
41	Brown Pelican	Calipatria, CA	16	<LOQ	x	x
42	Brown Pelican	Calipatria, CA	36	<LOQ	#	NA
43	Brown Pelican	Calipatria, CA	<LOQ	<LOQ	NA	NA
44	Brown Pelican	Calipatria, CA	6	<LOQ	NA	NA
45	Brown Pelican	Calipatria, CA	32	<LOQ	NA	NA
46	Great Blue Heron	St. Martinville, LA	188	<LOQ	#	x
47	Great Blue Heron	St. Martinville, LA	59	<LOQ	#	x
48	Great Blue Heron	St. Martinville, LA	1061	19	NA	NA
49	Great Blue Heron	St. Martinville, LA	261	8	NA	NA
50	Great Blue Heron	St. Martinville, LA	173	12	NA	NA
51	White Pelican	Fallon, NV	141	<LOQ	#	x
52	White Pelican	Fallon, NV	362	<LOQ	x	x
53	White Pelican	Fallon, NV	927	<LOQ	NA	NA
54	White Pelican	Fallon, NV	133	<LOQ	NA	NA
55	White Pelican	Fallon, NV	291	<LOQ	NA	NA
56	Brown Pelican	Ft. Lauderdale, FL	194	11	x	x
57	Brown Pelican	Ft. Lauderdale, FL	75	8	#	x
58	Brown Pelican	Ft. Lauderdale, FL	71	<LOQ	NA	NA
59	Brown Pelican	Ft. Lauderdale, FL	31	<LOQ	NA	NA
60	Brown Pelican	Ft. Lauderdale, FL	91	8	NA	NA

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3M Environmental Lab - Fluorine Analytical Chemistry Team

Semi-quantitative results of the analysis of wild bird livers

SAMPLE NUMBER	SPECIES	LOCATION	Liver [PFOS] ppb	Liver [PFOSA] ppb	Avg. [PFOS] ppb	Avg. [PFOS]ppb*
4291001	sandhill crane	Kearney, NE	41	<LOQ		
4291008	sandhill crane	Kearney, NE	<LOQ	<LOQ		
4291009	sandhill crane	Kearney, NE	<LOQ	<LOQ		
4291021	sandhill crane	Kearney, NE	<LOQ	<LOQ		
4291058	sandhill crane	Kearney, NE	<LOQ	<LOQ	<LOQ	<LOQ
4296008	sandhill crane	Cochise Co., AZ	<LOQ	<LOQ		
4296009	sandhill crane	Cochise Co., AZ	<LOQ	<LOQ		
4296014	sandhill crane	Cochise Co., AZ	<LOQ	<LOQ		
4296017	sandhill crane	Cochise Co., AZ	<LOQ	<LOQ		
4296018	sandhill crane	Cochise Co., AZ	<LOQ	<LOQ	<LOQ	<LOQ
4337001	white pelican	Calipatria, CA	35	<LOQ		
4337003	white pelican	Calipatria, CA	1293	<LOQ		
4337004	white pelican	Calipatria, CA	29	<LOQ		
4337017	white pelican	Calipatria, CA	15	<LOQ		
4337018	white pelican	Calipatria, CA	155	<LOQ	305	58
4306020	brandt's cormorant	San Diego, CA	53	80		
4306021	brandt's cormorant	San Diego, CA	46	31		
4306022	brandt's cormorant	San Diego, CA	46	34		
4306051	brandt's cormorant	San Diego, CA	80	13		
4306056	brandt's cormorant	San Diego, CA	2055	94	456	56
4312001	double-crested cormorant	St. Martinville, LA	59	20		
4312002	double-crested cormorant	St. Martinville, LA	145	7		
4312005	double-crested cormorant	St. Martinville, LA	333	23		
4312006	double-crested cormorant	St. Martinville, LA	76	<LOQ		
4312007	double-crested cormorant	St. Martinville, LA	170	<LOQ	157	157
4360020	brown pelican	Miami, FL	106	58		
4360021	brown pelican	Miami, FL	134	11		
4360022	brown pelican	Miami, FL	125	10		
4360023	brown pelican	Miami, FL	159	47		
4360024	brown pelican	Miami, FL	48	11	115	115
4295007	sandhill crane	Valencia Co., NM	<LOQ	<LOQ		
4295008	sandhill crane	Valencia Co., NM	<LOQ	<LOQ		
4295014	sandhill crane	Socorro Co., NM	<LOQ	<LOQ		
4295017	sandhill crane	Socorro Co., NM	<LOQ	<LOQ		
4295018	sandhill crane	Valencia Co., NM	<LOQ	<LOQ	<LOQ	<LOQ
4392003	double-crested cormorant	Naples, FL	212	9		
4392004	double-crested cormorant	Naples, FL	10	<LOQ		
4392005	double-crested cormorant	Naples, FL	52	<LOQ		
4392006	double-crested cormorant	Naples, FL	100	35		
4392007	double-crested cormorant	Naples, FL	152	24	105	105
4336003	brown pelican	Calipatria, CA	16	<LOQ		
4336006	brown pelican	Calipatria, CA	36	<LOQ		
4336010	brown pelican	Calipatria, CA	<LOQ	<LOQ		
4336012	brown pelican	Calipatria, CA	6	<LOQ		
4336013	brown pelican	Calipatria, CA	32	<LOQ	<22	22
4311003	great blue heron	St. Martinville, LA	188	<LOQ		
4311005	great blue heron	St. Martinville, LA	59	<LOQ		
4311006	great blue heron	St. Martinville, LA	1061	19		
4311007	great blue heron	St. Martinville, LA	261	8		
4311009	great blue heron	St. Martinville, LA	173	12	348	348
4328007	white pelican	Fallon, NV	141	<LOQ		
4328053	white pelican	Fallon, NV	362	<LOQ		
4328054	white pelican	Fallon, NV	927	<LOQ		
4328056	white pelican	Fallon, NV	133	<LOQ		
4326057	white pelican	Fallon, NV	291	<LOQ	371	371
4378005	brown pelican	Ft. Lauderdale, FL	194	11		
4378011	brown pelican	Ft. Lauderdale, FL	75	8		
4378013	brown pelican	Ft. Lauderdale, FL	71	<LOQ		
4378014	brown pelican	Ft. Lauderdale, FL	31	<LOQ		
4378016	brown pelican	Ft. Lauderdale, FL	91	8	92	92

* Average when outliers are excluded

LOQ = limit of quantitation (approx. 6 ppb)

MS-Sandhill Crane 77% 96%
MSD-Sandhill Crane 64% 64%

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Qualitative results of the analysis of wild bird livers

SAMPLE NUMBER	SPECIES	LOCATION	Liver [PFOS] ppb	PFHS?	PFDS?
4291001	sandhill crane	Kearney, NE	41	X	**
4291008	sandhill crane	Kearney, NE	<LOQ	not measured	not measured
4291009	sandhill crane	Kearney, NE	<LOQ	**	**
4291021	sandhill crane	Kearney, NE	<LOQ	not measured	not measured
4291058	sandhill crane	Kearney, NE	<LOQ	not measured	not measured
4296008	sandhill crane	Cochise Co., AZ	<LOQ	**	X
4296009	sandhill crane	Cochise Co., AZ	<LOQ	**	X
4296014	sandhill crane	Cochise Co., AZ	<LOQ	not measured	not measured
4296017	sandhill crane	Cochise Co., AZ	<LOQ	not measured	not measured
4296018	sandhill crane	Cochise Co., AZ	<LOQ	not measured	not measured
4337001	white pelican	Calipatria, CA	35	X	X
4337003	white pelican	Calipatria, CA	1358	X	X
4337004	white pelican	Calipatria, CA	30	not measured	not measured
4337017	white pelican	Calipatria, CA	17	not measured	not measured
4337018	white pelican	Calipatria, CA	167	not measured	not measured
4306020	brandt's cormorant	San Diego, CA	57	**	X
4306021	brandt's cormorant	San Diego, CA	50	not measured	not measured
4306022	brandt's cormorant	San Diego, CA	46	not measured	not measured
4306051	brandt's cormorant	San Diego, CA	85	not measured	not measured
4306056	brandt's cormorant	San Diego, CA	2176	X	X
4312001	double-crested cormorant	St. Martinville, LA	61	X	X
4312002	double-crested cormorant	St. Martinville, LA	149	**	X
4312005	double-crested cormorant	St. Martinville, LA	336	not measured	not measured
4312006	double-crested cormorant	St. Martinville, LA	78	not measured	not measured
4312007	double-crested cormorant	St. Martinville, LA	178	not measured	not measured
4360020	brown pelican	Miami, FL	115	**	X
4360021	brown pelican	Miami, FL	149	**	X
4360022	brown pelican	Miami, FL	126	not measured	not measured
4360023	brown pelican	Miami, FL	166	not measured	not measured
4360024	brown pelican	Miami, FL	49	not measured	not measured
4295007	sandhill crane	Valencia Co., NM	11	**	**
4295008	sandhill crane	Valencia Co., NM	9	**	**
4295017	sandhill crane	Socorro Co., NM	<LOQ	not measured	not measured
4295018	sandhill crane	Valencia Co., NM	<LOQ	not measured	not measured
4295014	sandhill crane	Socorro Co., NM	<LOQ	not measured	not measured
4392003	double-crested cormorant	Naples, FL	226	**	X
4392004	double-crested cormorant	Naples, FL	11	**	**
4392005	double-crested cormorant	Naples, FL	54	not measured	not measured
4392006	double-crested cormorant	Naples, FL	103	not measured	not measured
4392007	double-crested cormorant	Naples, FL	154	not measured	not measured
4336003	brown pelican	Calipatria, CA	16	X	X
4336006	brown pelican	Calipatria, CA	37	**	X
4336010	brown pelican	Calipatria, CA	<LOQ	not measured	not measured
4336012	brown pelican	Calipatria, CA	7	not measured	not measured
4336013	brown pelican	Calipatria, CA	33	not measured	not measured
4311003	great blue heron	St. Martinville, LA	202	**	X
4311005	great blue heron	St. Martinville, LA	61	**	X
4311006	great blue heron	St. Martinville, LA	1143	not measured	not measured
4311007	great blue heron	St. Martinville, LA	274	not measured	not measured
4311009	great blue heron	St. Martinville, LA	178	not measured	not measured
4328007	white pelican	Fallon, NV	146	**	X
4328053	white pelican	Fallon, NV	368	X	X
4328054	white pelican	Fallon, NV	941	not measured	not measured
4328056	white pelican	Fallon, NV	141	not measured	not measured
4326057	white pelican	Fallon, NV	294	not measured	not measured
4378005	brown pelican	Ft. Lauderdale, FL	212	X	X
4378011	brown pelican	Ft. Lauderdale, FL	76	**	X
4378013	brown pelican	Ft. Lauderdale, FL	72	not measured	not measured
4378014	brown pelican	Ft. Lauderdale, FL	32	not measured	not measured
4378016	brown pelican	Ft. Lauderdale, FL	94	not measured	not measured

X = detected ** = not detected

PFOSAA, M556, M570, POAA, and M513 were not detected in the livers of any birds.

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3M Environmental Lab - Fluorine Analytical Chemistry Team

PFS's

PFHS	perfluorohexanesulfonate	C6F13SO3-
PFOS	perfluorooctanesulfonate	C8F17SO3-
PFOSA		C8F17SO2NH2
PFOSAA		C8F17SO2N((CH2CH3)(CH2COO))-
M556		C8F17SO2N((H)(CH2COO))-
M570		C8F17SO2N((CH3)(CH2COO))-
PFOSEA	perfluorooctanesulfonylethyl amide	C8F17SO2N((CH2CH3)(H))
Et-FOSE-OH		C8F17SO2N((CH2CH3)(CH2CH2OH))
PFDS	perfluorodecanesulfonate	C10F21SO3-**

PFCA's

POAA	perfluorooctanoate	C7F15COO-
M513	perfluorodecanoate	C9F19COO-
M613	perfluorododecanoate	C11F23COO-
M463		C8F17COO-
M563		C10F21COO-
M363		C6F13COO-

PFS = perfluorinated sulfoante

PFCA = perfluorinated carboxylic acid

** no standard material available for confirmation;