

Toxicological Summary

PFOS

Dietary Chronic Pilot Reproductive Study: Northern Bobwhite

- Test Substance:** Perfluorooctanesulfonate (PFOS)
- Structure:** 1-Octanesulfonic acid, 1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptafluoro-potassium salt. CAS# 2795-39-3
- Test Remarks:** The test substance is a white powder (3M Lot # 217). The sample was stored under ambient conditions and purity was determined to be 86.9% by LC/MS, ¹H-NMR, and elemental analysis techniques.

METHODS

Method: ASTM Standard E1062-86 and FIFRA Subdivision E., Section 71-4.

Type: Dietary Reproduction

Year: 2000 in-life phase, 2000-2001 analytical phase, 2003 for final report.

Species: Northern Bobwhite (*Colinus virginianus*)

Experimental design: Adult bobwhite quail were exposed to PFOS in the diet at nominal concentrations of 1.8, 6.2, or 17.6 ppm, wet weight for a period of six weeks. Concurrently, a control group was maintained on a non-treated feed. After six weeks of exposure, quail from the 1.8 and 6.2 ppm treatment groups were euthanized and subjected to gross necropsy. The control and 17.6 ppm treatment groups were maintained on the respective exposure regimes until Week 20, at which time they also were euthanized and necropsied (Table 1). Effects on adult health, body weight and feed consumption were evaluated weekly. Because the two lower doses were terminated at six weeks, statistical evaluation of the data was done in two separate analyses. The first analysis evaluated all data collected up through Week 6 for all treatment groups. The second analysis examined data from the control and 17.6 ppm treatment groups from Weeks 6 to 20.

Adult quail were brought into reproductive phase prior to the onset of the study by photostimulation. Consequently, initiation of egg laying began during the first week of dosing. A subset of eggs collected during Weeks 1 and 6 of the test were analyzed for PFOS. Eggs laid during a 7-day period starting on the second day of Week 5 were collected, incubated, and reproductive endpoints were evaluated. Reproductive endpoints, including egg production, embryo viability, hatchability, health, and survival, were evaluated in this egg cohort. Offspring were maintained on non-treated feed for approximately 12 weeks. Necropsies were performed on offspring from each treatment group. Liver weights were recorded for all necropsied quail. In addition, samples of liver, brain, kidney, gonad, proventriculus, gall bladder, adipose tissue, and Bursa of Fabricius samples were collected from adult and offspring for histopathological examination.

At the end of Week 6, blood samples were collected from all surviving adult birds from the 1.8 and 6.2 ppm treatment groups and were then euthanized and necropsied. At the time of necropsy, livers were also collected for chemical analysis. Blood samples were also collected from adult birds in the control and 17.6 ppm treatment groups prior to euthanasia and necropsy at the beginning of Week 20. At necropsy, liver samples were also collected from adult birds for chemical analysis. Prior to euthanasia of the offspring, blood samples were collected from 10 offspring from each treatment group. Additionally, tissues from 10 offspring were collected from each treatment group for analysis. All blood collected from adult and offspring was separated into serum and hemacyte/platelet fractions.

Table 1. Experimental design for the dietary chronic pilot reproductive study with Northern bobwhites.

Treatment (ppm)	Exposure Period (week)	Endpoints Examined
Control	20	
1.8	6	Health, body weight, feed consumption, gross morphology and histopathology of body organs, egg production, embryo viability, hatchability, offspring health and survival, PFOS concentrations in liver, egg membrane, yolk, albumin, and blood serum of adult and offspring quails.
6.2	6	
17.6	20	

Test Bird Age: Adult quail (approximately 30 weeks old at exposure initiation)

Number of Replicates: Five replicates (pens) per treatment group

Quail per Replicate: One male and female per pen

Feed and Water: Food and water were provided *ad libitum* during all phases of the study to both adult quail and offspring. Feed consumption was measured on a per pen basis, once a week.

Analytical Monitoring: PFOS concentrations in feed, liver and serum samples were determined by reverse-phase HPLC and mass spectrometry.

Statistical Methods: Upon completion of the test, an analysis of variance (ANOVA) was performed to evaluate significant differences between treatment groups. Dunnett's multiple comparison procedure was used to compare the treatment effects with control. The student's T-test was used to make statistical comparisons in those instances where only the control and the 17.6 ppm treatment groups were compared.

Average Daily Intake (ADI) of PFOS for each treatment group was estimated using data

from each pen in that treatment group, without taking into account potential differences between the male and female paired within a pen. Food consumption and adult quail body weight data were averaged over the duration of the study and the ADI was calculated as follows:

$$\text{ADI(mg/kg/day)} = \frac{\text{AverageFeed Consumption (g feed/bird/ day)}}{\text{AverageBody weight (g/bird)}} \times \text{FeedConc.(ppm)} \quad (\text{Equation 1})$$

Test Diet Preparation: Test diets were prepared by mixing PFOS into a premix that was used for weekly preparation of the final diet.

RESULTS

Measured Diet Concentrations: Chemical analyses were conducted by Wildlife International Ltd. to confirm PFOS concentrations in the diets. The limit of quantitation (LOQ) was equivalent to 0.879 ppm, wet weight during Week 1 of the study, while for Week 6 the LOQ was 1.41 ppm. The percent recoveries of matrix spikes (averaged across replicate samples) from the test diets ranged from 97.0 to 113%. Analyses of control diets showed no presence of the test substance or other co-eluting compounds. Samples collected for verification of diet PFOS concentrations from the treatment groups had measured values that ranged from 95 to 111% of the nominal PFOS concentrations. The mean measured PFOS concentrations for diets used in the study were:

<LOQ, 1.8, 6.0 and 17.6 ppm in feed

Analysis of diet samples collected from feeders after being held at ambient temperatures for 7 days averaged 100%, 103% and 98% of the Week 1, Day 0 values for the 1.8, 6.2 and 17.6 ppm diet treatments, respectively.

Mortalities and Clinical Observations: No adult mortalities occurred in any treatment group during the study. While several quail were noted with head or foot lesions and feather loss, these signs were considered to be the result of pen wear and/or pen-mate aggression that occurred during the course of the test. All other quail were found to be normal in appearance and behavior.

Adult Body Weight: At both 6 and 20 weeks, no adverse effects on body weight were observed in females from any of the treatment groups when compared to controls (Table 2). In males, there was a statistically significant ($p < 0.05$) reduction in body weight in the 17.6 ppm treatment group at Week 6 and at Week 20 (8.8% reduction from controls). It was concluded that this reduction in body weight was treatment-related. For adult males, a No Observable Adverse Effect Concentration (NOAEC) was determined to be 6.2 ppm PFOS and the Lowest Observable Adverse Effect Concentration (LOAEC) was determined to be 17.6 ppm PFOS. The NOAEC for females was determined to be greater than or equal to 17.6 ppm PFOS.

Feed Consumption: No treatment-related effects on food consumption were noted in the 1.8 and 6.2 ppm treatment groups at Week 6. While there were statistically significant reductions in food consumption at these exposures, these reductions were not considered treatment-related due to the lack of a dose-response relationship. The significance of the apparent reduction at Week 6 at these two doses may have been a consequence of a relatively large increase in feed consumption in the control group at this time interval as compared to that observed at Weeks 5 or 7. Thus, the feed consumption rate in all PFOS treatment groups was significantly reduced from that in the control group at Week 6. Moreover, feed consumption rate in PFOS treatment groups at Week 6 were greater than feed consumption rates measured at Week 5 for the same treatment groups. There was a consistent and statistically significant ($p < 0.05$) reduction in feed consumption among bobwhite quail in the 17.6 ppm PFOS treatment as compared to quail in the control treatment at Weeks 2, 3, 4, 6, 8, and 15. The average feed consumption rates in the control and 17.6 ppm treatments at Week 20 were 28.8 g feed/bird-day and 24.4 g feed/bird-day, respectively. Based on results from the Week 6 statistical analysis, the NOAEC and LOAEC for feed consumption was 6.2 and 17.6 ppm, respectively (Table 2).

Table 2. Average daily exposure, feed consumption, body and liver weight of adult quail exposed to PFOS in the diet. ^A

Treatment (ppm)	ADI ^B (mg/kg body weight/day)	FC ^C (g feed /bird/day)	Sex	Body Weight (g)		Liver weight (g)
				Week 6	Week 20	
Control	<LOQ	28 ± 2	M	213 ± 7	216 ± 7	3.402 ± 0.446
			F	234 ± 12	232 ± 21	7.645 ± 1.295
1.8	0.174 ± 0.007	22* ± 2	M	212 ± 14		3.501 ± 0.514
			F	211 ± 36		6.323 ± 1.668
6.2	0.579 ± 0.066	23* ± 3	M	207 ± 11		3.684 ± 0.686
			F	235 ± 23		5.623 ± 0.505
17.6	2.009 ± 0.249	23* ± 2	M	196* ± 6	197* ± 7	2.527* ± 0.359
			F	231 ± 14	220 ± 33	6.851 ± 1.880

^A. Control and 17.6 ppm treatments were sacrificed at Week 20 while the 1.8 and 6.2 ppm treatments were sacrificed at Week 6. All values are given as means and standard deviations.

^B. Average Daily Intake (ADI; mg PFOS/kg body weight per day) of PFOS was based on average food consumption through Week 6 for the 1.8 and 6.2 ppm groups and through Week 20 for the control and 17.6 ppm groups.

^C. Food consumption based on Week 6 data.

Asterisk indicates a statistical difference from the control treatment at $p < 0.05$.

Liver Weight: Since adult quail from the 1.8 and 6.2 ppm treatments were terminated at Week 6, it was not possible to compare these two treatment groups to the controls at Week 20. Only the control and 17.6 ppm treatments were statistically evaluated. Male bobwhite quail in the 17.6 ppm treatment had a statistically significant reduction in liver weight when compared to controls (Table 2). In females, liver weights in the 17.6 ppm treatment group were not statistically significantly different from controls. Thus, for male quail the LOAEC based on decreased liver weight was 17.6 ppm, while in females, the NOAEC was greater than or equal to 17.6 ppm.

Gross Pathology: Adult quail in the 1.8 and 6.2 ppm treatments were sacrificed at Week 6, while quail in the control and 17.6 ppm treatments were sampled at Week 20. All quail were subjected to gross necropsy. All findings were considered to be incidental and not related to treatment. Incidence of small testes was noted during the gross necropsy in the 17.6 ppm treatment group.

Ten juvenile offspring (approximately 12 weeks old) from each treatment group were sampled and subjected to gross necropsy. While feather loss was observed in juvenile quail, this loss was considered to be incidental and unrelated to treatment since the frequency of loss was equivalent across treatment levels. No other findings were considered to be treatment related in the offspring.

Histopathology: There were no lesions in the liver, kidney, proventriculus, gall bladder, ovary, brain, or bursa fabricius in quail offspring at any of the PFOS concentrations tested or in adult birds collected from the control and 17.6 ppm treatments. In addition, there were no treatment-related lesions observed in the adipose tissues or testes of adult or juvenile bobwhites. However, there was an increase in the incidence of small testes size in males from the 17.6 ppm treatment, and this was correlated with a decrease in seminiferous tubule diameter. While a decrease in testes size is consistent with post-reproductive phase regression, a normal physiological phenomenon, the frequency of the incidence of decreased testes size was greatest in the 17.6 ppm treatment. However, since there was a small sample size of birds at this treatment (N=5), the significance of this observations relative to PFOS-related effects can not be determined at this time. Spermatogenesis did not appear to be adversely affected in the 17.6 ppm treatment when compared to control males.

Reproductive Results: There were no PFOS-related effects on bobwhite quail egg production when compared to the control group. In addition, there were no PFOS-related effects on embryo viability, hatchability, hatchling health, and survivability. While there was a statistically significant ($p < 0.05$) reduction in the number of viable embryos in the 1.8 ppm treatment, this was a consequence of fewer eggs being set for this treatment group. When reproductive endpoints were expressed as percentages, no statistically significant differences were observed among any of the PFOS treatments when compared to controls. While there was a slight reduction in embryo viability among quails exposed to 6.2 ppm PFOS, this effect was not considered dose related since a reduction in viability was not observed in the 17.6 ppm treatment.

Hatchling and Offspring Results: In comparison to controls, there were no PFOS treatment-related effects on the body weight of either hatchling or juvenile bobwhite quail (Table 3). In addition, there were no effects on juvenile liver weight for any PFOS treatments when compared to control liver values. Based on these results, the NOAEC for offspring endpoints was greater than or equal to 17.6 ppm.

Table 3. Mean liver and body weight of offspring bobwhite quail. ^A

Treatment	Body Weight (g) ^B		Juvenile Liver Weight (g)
	Hatchling	Juvenile	
Control	6.1 ± 0.5	175 ± 10	3.746 ± 0.339
1.8 ppm	5.6 ± 0.5	175 ± 1	3.756 ± 0.453
6.2 ppm	5.7 ± 0.6	179 ± 5	4.985 ± 1.367
17.6 ppm	6.0 ± 0.5	173 ± 8	3.429 ± 0.495

^A All data presented as means and standard deviations.

^B Body and liver weights for juveniles were measured approximately 12 weeks post-hatch.

Blood and Liver PFOS Analysis:

PFOS Concentrations in Adults

Results of the chemical analysis of blood and liver showed that the adult quail accumulated PFOS in a dose dependent manner (Table 4).

Table 4. Summary of analytical results for adult quail liver and serum samples collected during the pilot PFOS reproduction study. ^A

Treatment (ppm)	Exposure duration (week)	Sex	Liver Conc. ^B	Serum Conc. ^B
			(µg/g)	(µg/mL)
Control	20	M	0.188 ± 0.093	7.30 ± 4.49
		F	<LOQ	1.63 ± 3.18
1.80	6	M	0.352 ± 0.268	18.7 ± 10.7
		F	0.103 ± 0.089	3.73 ± 4.00
6.20	6	M	1.29 ± 0.189	77.3 ± 17.3
		F	0.14 ± 0.06	3.22 ± 0.97
17.6	20	M	2.90 ± 2.91	199 ± 58.3
		F	1.36 ± 1.61	44.5 ± 47.5

^A Liver and serum concentrations reported as means and standard deviations. All values are reported on a wet weight basis. The LOQ for liver was 0.01 µg/g and for serum it was 0.01 µg/mL.

^B Liver and serum concentrations were averaged for each replicate sample (n=2) and then samples were averaged across an entire treatment. Both replicates in three out of five liver samples from female quail from the control treatment had values below the analytical limit of quantitation (LOQ). To obtain the mean and standard deviation for this group, the value 0.00005 µg/g (one half of the value of the lowest calibration standard, 0.0001 µg/mL) was used for values reported as < LOQ. All other liver samples and all sera samples were reported above the LOQ.

Analytical results showed that there was a marked difference in liver and serum PFOS concentrations between male and female bobwhite quail. In males, liver concentrations were typically 2 to 94 times greater than that observed in females within the same treatment groups. The same was observed for serum concentrations of PFOS. Male bobwhite quail had serum PFOS concentrations that were 4 to 24 times greater than the concentrations observed in females sampled from the same treatment group. The relationship between liver and serum concentrations was variable and differed across treatment groups. Serum to liver ratios ranged from 0.11 to 262 in males and from 3.2 to

150 in females. The serum to liver relationships for PFOS concentrations in adult bobwhite quail were:

Male: Serum PFOS ($\mu\text{g/mL}$) = $91.638 (\text{Liver PFOS, } \mu\text{g/g}) - 4.8447$ $R^2 = 0.5997$

Female: Serum PFOS ($\mu\text{g/mL}$) = $15.653 (\text{Liver PFOS, } \mu\text{g/kg}) + 5.5355$ $R^2 = 0.3290$

The analytical data also indicated that there was a dose dependent increase in both liver and serum PFOS concentrations but that these data were sex specific and highly variable. To examine the relationship between PFOS exposure and tissue concentrations, the estimated average daily intake (ADI) of PFOS by adult quail was compared to liver and serum concentrations collected from each treatment. An ADI was used in this analysis because this parameter is used as a measure of exposure that adult birds may encounter in the environment. The results of the regression analysis for both serum and liver PFOS concentrations and ADI are given below:

Male:

Serum PFOS ($\mu\text{g/mL}$) = $94.948 (\text{ADI, mg/kg body weight/day}) + 9.344$ $R^2 = 0.8964$

Liver PFOS ($\mu\text{g/g}$) = $1.2602 (\text{ADI, mg/kg body weight/day}) + 0.3118$ $R^2 = 0.3233$

Female:

Serum PFOS ($\mu\text{g/mL}$) = $23.148 (\text{ADI, mg/kg body weight/day}) - 2.5198$ $R^2 = 0.4080$

Liver PFOS ($\mu\text{g/g}$) = $0.7149 (\text{ADI, mg/kg body weight/day}) - 0.093$ $R^2 = 0.3871$

These regression models are in agreement with the serum: liver ratio data that showed that males accumulated greater concentrations of PFOS in both the liver and blood serum in comparison to female bobwhite quail. However, the time-dependent accumulation of PFOS by males and females is unknown, and the impact of egg production on female serum and liver PFOS concentrations could not be determined from this study. Without additional pharmacokinetic data, a more accurate evaluation of PFOS uptake and depuration could not be conducted at this time. Overall, it was concluded that serum and liver PFOS concentrations should be evaluated on a sex-specific basis.

PFOS Concentrations in Juveniles

Chemical analyses of 12-week old juvenile quail serum and liver samples indicate that PFOS concentrations persist in juvenile quail (Table 5). Juvenile quail were not exposed to PFOS post-hatch, rather their serum and liver PFOS concentrations were entirely due to contributions into the egg from adult female quails. These concentrations represent that which remained in the juvenile quails after 12 weeks of growth and depuration. The concentrations are not representative of that found in quail immediately post-hatch.

Table 5. Concentrations of PFOS in the liver and serum of 12-week old juvenile quail ^A

Treatment (ppm)	Liver Conc. (µg/g)	Serum Conc. (µg/mL)
Control	<LOQ ^B	<LOQ
1.8	<LOQ	0.0324 ± 0.0198
6.2	0.0182 ± 0.0156	0.203 ± 0.0838
17.6	0.0593 ± 0.0417	0.413 ± 0.1140

^A All concentrations are presented as means with standard deviations. Data is given on a wet weight basis.

^B The LOQ for liver was 0.01 µg/g and for serum it was 0.01 µg/ml.

To assess the quantitative relationship between juvenile liver and serum PFOS concentrations and egg yolk concentrations, a regression analysis was conducted. This analysis included all the data, including data that was above the limit of detection (LOD) but less than the LOQ, from each PFOS treatment group. The relationship between average egg yolk and juvenile serum and liver PFOS concentrations are:

$$\begin{aligned} \text{Liver PFOS } (\mu\text{g/g}) &= 0.001 (\text{Egg yolk, } \mu\text{g/ml}) - 0.0043 & R^2 &= 0.9002 \\ \text{Serum PFOS } (\mu\text{g/ml}) &= 0.007(\text{Egg yolk, } \mu\text{g/ml}) - 0.0064 & R^2 &= 0.9867 \end{aligned}$$

Thus, juvenile liver and serum PFOS concentrations are highly correlated with egg yolk concentrations.

Juvenile liver and serum PFOS concentrations increased in a dose dependent manner with the greatest concentrations being measured in quail from the 17.6 ppm diet treatment. The serum to liver relationships was:

$$\text{Serum PFOS } (\mu\text{g/mL}) = 4.3533(\text{liver PFOS, } \mu\text{g/g}) + 0.0720 \quad R^2 = 0.6041$$

Serum and liver levels in juveniles thus are correlated. The serum to liver ratio for juvenile bobwhite quail was 28 ± 36.2 and ranged from 0.77 to 147. The range of the juvenile serum: liver ratio was within the ranges observed for the adult quail, independent of sex.

Egg component analysis: Eggs were sampled during the first and sixth week of egg production from the control, 6.2 and 17.6 ppm treatments (Table 6).

Table 6. Mean concentrations (with standard deviation) of PFOS (µg/ml) in quail eggs sampled during the pilot reproductive study. ^A

Treatment	Egg Membrane		Albumen		Yolk	
	1 week	6 week	1 week	6 week	1 week	6 week
Control	NQ	NQ	NQ	NQ	NQ	NQ
6.2 ppm	0.140 (0.025)	0.139 (0.038)	0.004 (0.002)	0.006 (0.001)	12.6 (3.15)	33.1 (7.61)
17.6 ppm	NR	0.311 (0.086)	0.016 (0.009)	0.014 (0.002)	38.7 (4.13)	56.5 (6.51)

^A. Concentrations for egg components are reported on a wet weight basis.

NR = not reported due to samples being contaminated.

NQ = not quantifiable; concentrations are below the limit of quantitation (0.0001 µg/ml).

A positive relationship was observed between PFOS exposure in adult hens and the concentration of PFOS in egg components sampled at Weeks 1 and 6. There were significant differences between the concentrations of PFOS measured in egg components, with the yolk having the greatest PFOS concentrations and the albumen having the least. When PFOS concentrations in egg components collected on Week 1 and Week 6 were compared, no significant differences were observed for either albumen or membrane PFOS concentrations. However, there was approximately a 2-fold increase in the yolk PFOS concentrations at Week 6 when compared to Week 1 concentrations. These results indicate that PFOS concentrations had most likely reached a saturation concentration in both egg membrane and albumen by the end of Week 1, but that PFOS concentrations in the yolk of the egg had not reached steady state by Week 6.

To examine the relationship between adult exposure and egg concentrations, regression analyses were conducted with the Week 6 egg yolk data and adult exposure endpoints. (The egg membranes were not evaluated due to contamination in the membrane sample preparation in the 17.6 ppm treatment). In addition, the albumen data was not analyzed due to the non-linear relationship between PFOS dose and concentrations of PFOS in the egg albumen. The quantitative relationship between adult female PFOS exposure endpoints and egg yolk concentrations for Week 6 were:

$$\text{Yolk } (\mu\text{g/mL}) = 24.696 (\text{ADI, mg/kg body weight/day}) + 8.4986 \quad R^2 = 0.7748$$

$$\text{Yolk } (\mu\text{g/mL}) = 6.012 (\ln \text{ Serum, } \mu\text{g/mL}) + 28.342 \quad R^2 = 0.6637$$

$$\text{Yolk } (\mu\text{g/mL}) = 5.4416 (\ln \text{ Liver, } \mu\text{g/g}) + 49.929 \quad R^2 = 0.8207$$

Since no PFOS-related adverse effects were observed for any reproductive parameter monitored in this study, quantitative relationships between egg concentrations and effects in hatchlings or juveniles were not studied for this project.

CONCLUSIONS:

Northern bobwhite quail were exposed to PFOS at nominal dietary concentrations of 0, 1.8, 6.2 and 17.6 ppm. The control and 17.6 ppm treatments were administered for 20 weeks while the 1.8 and 6.2 ppm treatments were administered for only 6 weeks.

No treatment related mortalities or overt signs of toxicity were observed for any PFOS concentration tested (Table 7). While there was a slight reduction in feed consumption at Week 6 among quail in the 17.6 ppm PFOS treatment, by Week 20 feed consumption rates had returned to control values. At Week 6 and Week 20 of the study, male bobwhite quail in the 17.6 ppm treatment had statistically significantly reduced body weights compared to controls. Liver weights in adult males from the 17.6 ppm treatment group were also significantly reduced from control values at Week 20. In addition, male quail in the 17.6 ppm treatment has an increased incidence of small testis size when compared to controls. While testicular regression is a normal physiological process, the biological significance of the increased incidence in the 17.6 ppm treatment group over that observed in the control group could not be evaluated due the small sample size (N=5). In addition, the significance of this finding is difficult to interpret in that no treatment-related or male-related effects were observed on reproduction in this study. No treatment-related effects were observed among female bobwhite quails at any PFOS concentration evaluated in the study.

There were no treatment-related effects on any reproductive parameter monitored in the study. There were no effects on survival, body weight or liver weight of offspring. Based on these results, the NOAEC and LOAEC for adult and juvenile endpoints evaluated in the study are given (Tables 7). The No Observable Adverse Effect Level (NOAEL) and Lowest Observable Adverse Effect Level (LOAEL) values for PFOS measured in various tissue matrices are also reported (Table 8).

Table 7. Measurement endpoints and associated dietary NOAEC and LOAEC values for PFOS in a chronic pilot study with bobwhite quail and their offspring.

Endpoint ^A	Dietary NOAEC (ppm)	Dietary LOAEC ^B (ppm)
ADULT		
Mortality	= 17.6	Not applicable
Body weight	Females $\geq$ 17.6 Males = 6.2	Females = Not applicable Males = 17.6
Feed consumption	6.2	17.6
Liver weight	Females $\geq$ 17.6 Males = 6.2	Females = Not applicable Males = 17.6
Gross pathology	$\geq$ 17.6	Not applicable
Histopathology	Females $\geq$ 17.6 Males = 6.2	Females = Not applicable Males = 17.6
Reproductive	$\geq$ 17.6	Not applicable
OFFSPRING		
14-day survivability	$\geq$ 17.6	Not applicable
Hatchling/juvenile body weight	$\geq$ 17.6	Not applicable
Juvenile liver weight	$\geq$ 17.6	Not applicable

^A Control and 17.6 ppm results are based on a 20 week exposure, while 1.8 and 6.2 ppm results are based on a 6 week exposure. All concentrations reported on a wet weight basis.

^B LOAEC for males based on a statistically significant reduction in body weight, liver weight and histopathology results.

Table 8. NOAEL and LOAEL values in various matrices in adult and offspring bobwhite quail in a chronic pilot study with PFOS.

Measures of PFOS Exposure ^A	NOAEL ^B	LOAEL ^C
ADULT MALES		
Dose (ppm)	6.2	17.6
ADI (ppm/day)	0.579	2.00
Serum (µg/ml)	77.3	199
Liver (ppm)	1.29	2.90
ADULT FEMALES		
Dose (ppm)	17.6	
ADI (ppm/day)	2.00	
Serum (µg/ml)	44.5	
Liver (µg/g)	1.37	
OFFSPRING		
Yolk (µg/ml) ^D	33.1	
Liver (µg/g)	0.059	
Serum (µg/ml)	0.413	

^A Control and 17.6 mg PFOS/kg results are based on Week 20, while the 6.2 ppm results are based on Week 6 data. All concentrations reported on a wet weight basis.

^B No and Low effect values for diet and ADI are reported as dietary concentrations. Serum and liver effect values are reported as measured tissue values.

^C LOAEL values for males based on body weight, liver weight and histopathology results.

^D Yolk PFOS concentration taken from week 6.

DATA QUALITY

Reliability: Klimish ranking = 1

REFERENCES:

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OTHER

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