APPENDIX A: Methodology for Developing PFAS Ecological Screening

CONTENTS

1 INTRODUCTION

1.1 Objectives

Argonne National Laboratory (Argonne) is working under the interagency direction of the U.S. Air Force Civil Engineer Center (AFCEC), with advice and input provided by the Tri-Services Environmental Risk Assessment Working Group (TSERA-WG, Chemical Material Risk Management Program), which is a chartered organization under the Office of Secretary of Defense, and the U.S. Environmental Protection Agency's (EPA's) Ecological Risk Assessment Forum (ERAF), referred to here as the Interagency Staff, to develop ecological screening values (ESVs) for use at Department of Defense (DOD) facilities with per- and polyfluorinated alky substances (PFAS) releases. ESVs, which represent contaminant levels below which ecological impacts are unlikely, support remedial investigations by focusing investigations in areas with concentrations that could have ecological impacts, and present a starting point for site-specific ecological risk assessments (EPA 1997). Argonne is working with AFCEC and the Interagency Staff to identify methods for reviewing the scientific literature on the effects of PFAS on ecological resources, to develop receptor-specific exposure scenarios and dose models, and to develop biota- and media-specific ecological screening values from this information. This report describes the methodology for deriving screening levels that will be developed in this collaborative effort.

1.2 General Process for Developing PFAS ESVs

Argonne will screen and review the available literature to identify a set of research studies meeting the selection criteria of this effort from which to develop screening levels. From these qualifying papers, Argonne will develop ecological screening values to the extent that information is available on PFAS chemicals, ecological receptors, and media in the qualifying papers. The methods used and the resulting uncertainty associated with the developed screening values will vary depending on the richness of the underlying data available in the literature. Rich datasets may produce robust and reliable screening values developed from well-defined dose-response curves covering a wide variety of ecological receptors. Datasets of intermediate richness would produce screening values of intermediate reliability, according to the depth and breadth of available toxicity response information. Last, our investigations may conclude that the uncertainty would be too high to develop screening values PFAS chemicals of interest, receptors, or media when data do not meet thresholds for quality and quantity. The developed screening values will be characterized with respect to overall uncertainty to aid users in their application.

Argonne worked with the Interagency Staff to develop the methodology for developing screening values. This methodology relies foundationally on EPA's Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs, EPA 2005) for developing PFAS soil screening values, and on *Guidelines for Developing Numerical Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (Stephan et al. 1985), as well as the 1995 *Final Water Quality Guidance for the Great Lakes System* (40 CFR 60 No. 56), referred to hereafter as the Great Lakes Water Quality Initiative guidance, or simply the GLI guidance (EPA 1995a, b) for developing surface water screening values. This report describes the development of ecological screening values for the following media and receptors:

- Soils for invertebrates,
- Soils for plants,
- Soils for wildlife,
- Surface water for aquatic species, and
- Surface water for aquatic-dependent wildlife.

Developing screening values for soils and surface waters involves variations on a common theme: identifying the point of onset of ecologically relevant effects to relevant species from estimated environmental exposures of specific PFAS. Developing screening values in soil for plants and soil invertebrates involves the following steps:

- Extract toxicity values from qualified published literature for direct soil exposures of specific PFAS to plant and invertebrate species representative the geographic region of interest (North America).
- Derive screening values as the geometric mean of toxicity values from top ranking studies with respect to bioavailability of PFAS in the test medium.

Developing soil-screening values for terrestrial wildlife involves the following steps:

- Extract toxicity values from qualified published literature for laboratory exposures of specific PFAS to test animals representing bird and mammal species.
- Develop PFAS toxicity reference values (TRVs) representing the onset of relevant effects from published toxicity values using, in descending order of preference, either a (1) benchmark dose, (2) no observed adverse effect level (NOAEL)/ lowest observed adverse effect level (LOAEL) approach, or (3) approximation approach.
- Identify the soil screening value as the soil concentration corresponding to the TRV for specific PFAS using a food-chain model that accounts for soil ingestion and the ingestion of soil-exposed prey by species representative of North American birds and mammals.

The following describes the basic steps for aquatic species in surface waters (fresh water or marine):

- Extract toxicity values from qualified published literature for exposures of specific PFAS to representative species of genera, which are, in turn, representative of aquatic systems of North America.
- Plot toxicity values in rank order for the onset of ecologically relevant effects—mortality, growth and development, and reproduction—as a species-sensitivity distribution.
- Identify the screening value as the exposure concentration resulting in the onset of effects on the roughly 5% most sensitive species and/or genera.

Identifying a surface water screening value for aquatic-dependent wildlife species involves a somewhat different approach:

- Identify toxicity values (test dose) for the onset of relevant ecological effects in tests on laboratory animals (birds and mammals).

- Identify representative receptor bird and mammal species from the geographic region of interest.
- From the test animal data, estimate a corresponding toxicity value for the representative species using uncertainty factors.
- Identify surface water screening values for representative species from estimates of water consumption and of prey consumption, accounting for uptake from surface water and bioaccumulation of PFAS in prey.

In the following sections, this report (1) identifies the data sources to be used, (2) identifies the criteria by which scientific literature will be reviewed for usability, (3) describes exposure scenarios for use in developing media- and dose-based screening values, and (4) describes how the selected data will be used to develop media- and dose-based screening values.

1.3 References

Stephen, C.E., D.I. Mound, D.J. Hansen, J.R. Gentile, G.A. Chapman, and W.A. Brungs. 1985. *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*. PB85-227049. Prepared by U.S. Environmental Protection Agency Office of Research and Development, Environmental Research Laboratories, Duluth, MN.

EPA (U.S. Environmental Protection Agency). 1995a. "appendix A: Great Lakes Water Quality Initiative Methodologies for Development of Aquatic Life Criteria and Values." Part 132. *Water Quality Guidance for the Great Lakes System*. 40 CFR Part 132.

EPA, 1997, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological risk Assessments*, Interim Final. EPA 540-R-97-006. June.

EPA. 2005. *Guidance for Developing Ecological Soil Screening Levels*. Washington, DC. OSWER Directive 9285.7-55.

2 DATA ACQUISITION AND EVALUATION

2.1 PFAS Study Set

Table 2-1 lists eight PFAS compounds that the U.S. Air Force identified for the development of ESVs. The study set is composed of homologs of carboxylic acids of from four to ten perfluorinated carbons and homologs of sulfonic acids of from four to eight perfluorinated carbons. Searches of ECOTOX and other databases will include both the protonated and deprotonated acids (anions), as well as various salts. For example, ECOTOX identifies six forms of PFOS, the acid and anion, plus the K, Li, Na and tetraethyl-ammonium salts. PFOA includes the acid, anion, and Na salt. Only the acid forms are shown in Table 2-1.

Table 2-1 PFAS Compounds Included in the Literature Search for ESV Development

PFAS Abbreviation and Compound Names	International Union of Pure and Applied Chemistry Nomenclature	Chemical Abstracts Service (CAS) Registry Number
Carboxylic Acids		
PFBA, perfluorobutanoic acid	2,2,3,3,4,4,4-heptafluorobutanoic acid	375-22-4
PFHxA, perfluorohexanoic acid	2,2,3,3,4,4,5,5,6,6,6-undecafluorohexanoic acid	307-24-4
PFOA, perfluorooctanoic acid	2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-pentadecafluorooctanoic acid	335-67-1
PFNA, perfluorononanoic acid	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluorononanoic acid	375-95-1
PFDA, perfluorodecanoic acid	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluorodecanoic acid	335-76-2
Sulfonic Acids		
PFBS, perfluorobutanesulfonic acid	1,1,2,2,3,3,4,4,4-nonafluorobutane-1-sulfonic acid	375-73-5
PFHxS, perfluorohexanesulfonic acid	1,1,2,2,3,3,4,4,5,5,6,6,6-tridecafluorohexane-1-sulfonic acid	355-46-4
PFOS, perfluorooctanesulfonic acid	1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluorooctane-1-sulfonic acid	1763-23-1

2.2 Literature Sources and Literature Search

2.2.1 ECOTOX Knowledgebase for Toxicity Data Searches

The ECOTOX database (https://cfpub.epa.gov/ecotox/) will be the primary literature source used by Argonne to identify studies and datasets that will be used to develop PFAS screening levels for aquatic species, terrestrial plants, soil invertebrates, and terrestrial wildlife (birds and mammals). ECOTOX was created and is maintained by the EPA's Center for Computational Toxicology and Exposure (CCTE), Great Lakes Toxicology and Ecology Division. ECOTOX integrated three previously existing databases (AQUIRE, PHYTOTOX, and TERRETOX), and was completed in 1996 and released as a web-based interface in 2000. The literature search method used by CCTE to continue to populate the ECOTOX reference database is described in the ECOTOX User Guide (CCTE 2018). ECOTOX consists primarily of peer-reviewed literature on the effects of toxic substances on aquatic and terrestrial organisms found through online searches of scientific databases from 1970 to the present. In addition, ECOTOX incorporated external datasets, including the following:

- EPA CCTE data consisting of 30-day acute toxicity test for fathead minnow.
- Aquatic acute toxicity test results for studies conducted by the U.S. Geological Survey, Biological Resources Division, Columbia Environmental Research Center.

CCTE applied screening criteria to identified literature before it was entered into the ECOTOX database and studies not satisfying the requirements in Table 2-2 are excluded (Figure 2-1). Most of the rejection criteria relate to whether the study documents key elements of exposure (e.g., chemical name, dose, duration, pathway) and experimental design (e.g., controls and replicates).

All references incorporated into the ECOTOX database are assigned a reference number for storage and retrieval. CCTE uses various quality assurance procedures during the literature acquisition and cataloging to ensure that the study information is encoded correctly in the database (CCTE 2018).

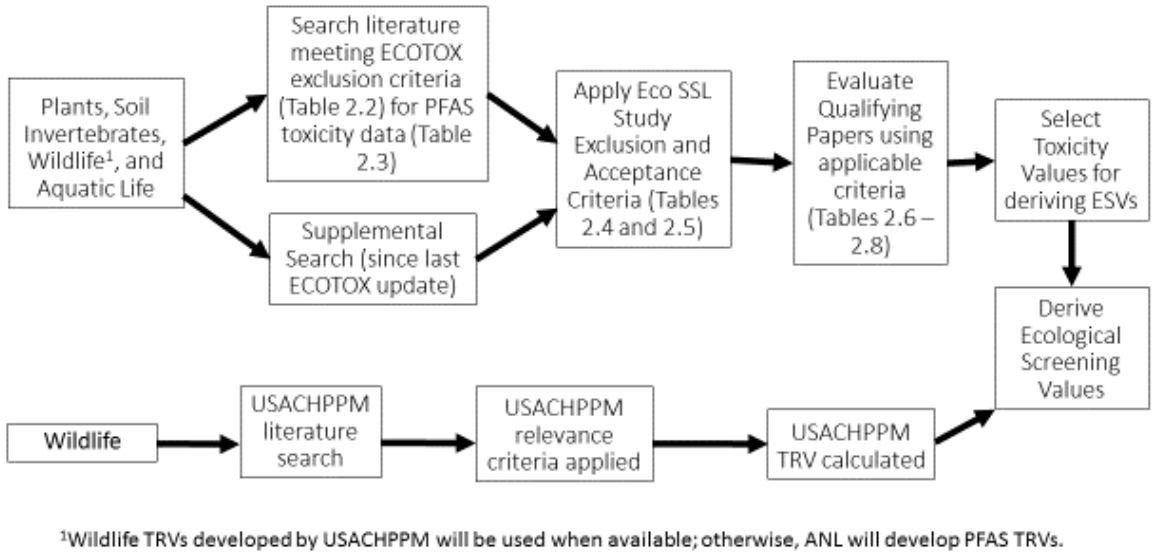

Figure 2-1. Data Acquisition and Evaluation Process Used in Screening Level Development

Table 2-2 Study Exclusion Criteria used by the ECOTOX Knowledgebase

Parameter	Inclusion Criteria	Exclusion Criteria
Chemical	• Single chemicals relevant to environmental exposure are included. • Verifiable CAS number.	• Mixtures (petroleum fuels). • Air pollution (CO_2 and ozone).
Species	• Ecologically relevant species. • Priority species are wild (test results for terrestrial domestic and laboratory species are used to fill data gaps when needed). • Organism taxonomic information verifiable against standard taxonomic sources.	• Human, monkey, bacteria, viral and yeast.
Effect/ Response	• Biological effect on live, whole organisms. • Adverse effects are priority (beneficial, nutritional effects are lower priority).	• Dead organisms.
Concentration/ Dose	• Concurrent environmental chemical concentration/dose reported as concentration, dose or application rate. • Sediment studies must have a water concentration reported to be included.	• Inhalation dose route (including intratracheal instillation) • Lead shot • Sediment only concentration • Unverified measurement unit. • Log values

Table 2-2 Study Exclusion Criteria used by the ECOTOX Knowledgebase

Exposure Duration	• Duration reports an associated concurrent with a biological effect	• Unverifiable duration
Publication/ Data Format	• Primary data source.	• Reviews
	• Full text English (some non-English papers are encoded that have an English abstracts)	• Full text foreign language.
		• Abstract only format

Source: Modified from NREERL (2018).

The ECOTOX database search interface contains multiple filters including "Chemicals," "All Effects," "All Endpoints," "All Species," "All Test Conditions," and "All Publication.". Within each of these filter categories are additional subfilter options to better target relevant literature. The database search filters that will be used by ANL are shown in Table 2-3. Under the "Perfluorooctane Sulfonates and Acids (PFOS/PFOA)" category in the ECOTOX database, Argonne will restrict the search to the eight specific compounds in Table 2-1.

In addition, only controlled laboratory studies will be used in most ESV development. Field-based studies will be excluded because the exposure regime and bioavailability are uncertain. However, field studies may be considered for the purposes of evaluating biomagnification and other food chain factors used in developing aquatic screening levels for wildlife (Table 2-8).

Table 2-3 ECOTOX Database Search Criteria for ESV Development

ECOTOX Parameters	ECOTOX Search Categories
Chemicals	Perfluorooctane sulfonates and acids (PFOS/PFOA)
All Effects	Growth (developmental; growth; morphological); mortality; reproduction; population
All Endpoints	Lethal concentration (LC_{xx})/lethal dose (LD_{xx}); effective concentration (EC_{xx})/effective dose (ED_{xx}); lowest observed effect concentration (LOEC); LOAEL; maximum acceptable toxicant concentration (MATC); no observed effect concentration (NOEC); NOAEL
All Species	Kingdom: Animals and plants (both)
All Test Conditions	Test Location: Laboratory Exposure Media: Water (freshwater, saltwater); soil (all categories); no substrate Exposure Type: Diet; environmental; not reported; flow through; intermittent; renewal; static Any Control Types: All ECOTOX control types and ECOTOX historical control types Any Chemical Analysis: Measured
Any Control Types	Any Independently Compiled Data: (all)

To develop PFAS ESVs, we will use only data from studies that test for ecologically relevant effects on reproduction, mortality, and growth. The following definitions are provided by ECOTOX (CCTE 2018) and EPA (2005) for growth, reproduction and mortality:

- *Growth*—Indicators of growth effects in the ECOTOX database covers specific measures of plant and animal growth (e.g., changes in organism weight, length, and biomass over time), as well as measurements of development and morphology. Development covers effects on tissue organization in growing early life stages. Morphology measurements and endpoints address the structure (bones) and form (organ/tissue development) of an organism at any stage of its life history (CCTE 2018).

- *Mortality*—Effect measurements of death include an actual count of the number dead or the percentage reduction within a population. An endpoint such as the LD_{50} estimates the effects to the population.

- *Reproduction*—Reproductive behavior, physiology, care of progeny and avian/reptile eggs measurements. Examples of measurements of reproductive effects include changes in reproductive behavior, abnormal progeny, fecundity, number of offspring produced, hatching rates, success, and/or viability; and reproductive success and/or capacity (e.g., offspring/adult/week). For plants, examples include changes in germination and seed yield.

Other effects reported in the ECOTOX database, such as physiological, cellular, biochemical/molecular and behavioral effects, will not be used in ESV development because of the difficulty of clearly and directly relating these effects to mortality, growth and reproduction.

The ECOTOX database is updated every three months. Argonne will conduct supplemental literature searches to capture any relevant literature published after the latest ECOTOX update. The literature search will generally follow the search procedure used by ECOTOX (CCTE 2018) and the U.S. Army Public Health Center (USAPHC; USACHPPM 2000; Deck and Johnson 2015) consisting of computerized searches of relevant biomedical, toxicological, and ecological databases (e.g., Google Scholar, Web of Science BIOIS, PubMed and TOXLINE). The U.S. Navy PFAS database will also be reviewed (https://intelshare.intelink.gov/sites/atlcoi/cmrm/PFAS/Forms/AllItems.aspx). As with the ECOTOX database search, Argonne will focus on controlled laboratory studies of PFAS effects on mortality, reproduction, and growth indicators.

2.2.2 USAPHC Literature Sources and Search Methods for Wildlife TRVs

Screening levels for wildlife will be based on TRVs provided by USAPHC, as available. Detailed information on literature search methods can be found in USAPHC Technical Guide No. 254 (USACHPPM 2000) and in Deck and Johnson (2015). In developing TRVs, USAPHC searches relevant databases such as ECOTOX, Web of Science, Integrated Risk Information System, Registry of Toxic Effects of Chemical Substances, and several National Library of Medicine databases (PubMed, TOXLINE, ATSDR Toxicity Profiles Hazardous Substances Data

Bank and Medline). Separate searches are conducted for birds, mammals, reptiles, amphibians, wildlife, and plants.

2.3 Initial Screening of Potentially Acceptable Literature

Studies initially identified in ECOTOX and supplemental literature searches will undergo a second screening process (ECOTOX screening being the first) based on the Eco-SSL criteria (EPA 2005) modified to reflect PFAS compounds (Figure 2-1). The overall objective will be to exclude studies not involving experimental PFAS exposures that measured defined endpoints to determine toxicological effects. Exclusions include studies of PFAS fate and transport, modeling studies, methods studies, reviews, studies of human health and in-vitro studies (Table 2-4). ECOTOX will have already screened out most such studies. The Eco-SSL criteria will also screen specifically for ESV development.

Table 2-4 Literature Exclusion Criteria

Criteria	Description
Contaminant Fate	Fate and transport of substance in the environment (only).
Human Health	Human or primate subjects.
In Vitro	In-vitro studies, including cell cultures and excised tissues.
Chemical Methods	Methods for measuring contaminants.
Modeling	Only modeling results reported.
No Species	No viable plant or animal present or tested.
No Effect	No effect was reported for a biological test species.
Published As	Study is not the primary source or author states information is published in another source.
QSAR	Data developed only from quantitative-structure activity relationships.
Review	Data reported are not primary data.
Mixture	Adverse effects are caused by a single chemical stressor (i.e., no mixture testing in laboratory studies.
Survey	Assessment of toxicity in the field over a period of time.

We will subject studies passing study exclusion criteria (Table 2-4) to a further acceptance evaluation applying the criteria listed in Table 2-5, which are modified Eco-SSL criteria (EPA 2005). Studies will not be considered acceptable for deriving ESVs if they lack key experimental information such as species, exposure concentration and duration, or if the study did not use controls (Table 2-5). We will identify literature that does not meet the acceptance criteria in our database, along with the reason for the exclusion.

Table 2-5 Study Acceptance Criteria

1. Either the test species' scientific name, common name, variety, or strain is reported.
2. The chemical form and concentration are reported.
3. Nominal and measured dose or concentration is reported, or able to be calculated from information given.
4. The duration of the exposure is reported.
5. Study used a control(s).
6. At least three treatment levels are used (i.e., control plus two chemical exposures).
7. Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.
8. A calculated endpoint is reported (e.g., LC_{50}, LOAEL, NOAEL).
9. Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.
10. Administered doses are provided or can be calculated from the information provided in the study (wildlife only).

Literature that passes the exclusion and acceptance criteria in Tables 2-4 and 2.5, respectively, will potentially be used to derive ESVs (Figure 2-1). We will apply additional evaluation criteria to score the quality of the studies to identify the studies from which to extract toxicity values for deriving ESVs and for characterizing the uncertainty of the derived values (Figure 2-1). The following sections describe this process.

2.4 Data Extraction and Evaluation

2.4.1 Plants and Soil Invertebrates

2.4.1.1 Ecologically Relevant Endpoints for Plants and Soil Invertebrates

To develop PFAS ESVs for plants and soil invertebrates, we will extract data from studies that passed the evaluations described above for ecologically relevant effects, which is based on the process outlined in Attachment 3-1 of the Eco-SSL Guidance (EPA 2005). For soil invertebrates, relevant effects are reproduction, mortality, and growth. For plants, relevant effects are growth and effects related to physiology, which includes net photosynthesis, chlorophyll content, deformation, membrane damage, desiccation dormancy measures, flowering, and senescence (EPA 2005).

For soil invertebrates, if a particular study reports toxicity values for different effects, the order of preferred effects for computing screening values will be reproduction > growth > mortality (EPA 2005).

For plants, effects on growth, as typically determined by biomass are preferred, with the physiology effects secondary to effects on biomass (EPA 2005).

2.4.1.2 Toxicity Parameters for Plants and Soil Invertebrates

Toxicity values preferred for deriving ESVs for plants and soil invertebrates are, in order, EC_{20} > MATC > EC_{10}. The MATC (maximum acceptable threshold concentration) is the geometric mean of the NOAEL and LOAEL. $EC_x < 5$ values are less preferred, because they are difficult to measure experimentally, while LC_{50} and EC_{50} values are not sufficiently protective of ecological resources. Similarly, unbounded NOAEL and LOAEL values are not acceptable for deriving ESVs, because they do not reliably identify a threshold of effects (i.e., a dose-response). If a given study identifies more than one adverse effect, we will use the use the effect with the lowest exposure concentration.

2.4.1.3 Evaluating and Scoring Studies for Plants and Soil Invertebrates

To identify the highest quality studies on which to base our derivation of ESVs for invertebrates and plants, we will systematically evaluate and score each accepted study against the nine scoring criteria outlined in Attachment 3-2 of the Eco-SSL Guidance (EPA 2005), with minor revisions to scoring Criterion 1, bioavailability, to account for differences in uptake behavior for PFAS as compared to that for metals and non-ionic organics for which the Eco-SSL Guidance (EPA 2005) was written. The nine scoring criteria are presented in Table 2-6.

Table 2-6 Summary of Nine Study Evaluation and Scoring Criteria for Applicability to Plant and Soil Invertebrate Development of PFAS ESVs

Criterion	Rationale	Scoring
1: Testing Was Done under Conditions of High Bioavailability	Bioavailability of metals and polar organic compounds is influenced by pH and soil organic matter, cationic exchange capacity, and clay content. The scoring is intended to favor relatively high bioavailability	Scores were based on the bioavailability matrix (see Chapter 2). Scored 2 if bioavailability of natural soil was high or very high. Scored 1 for natural soil with medium bioavailability or standard artificial soil. Scored 0 for natural soil with low and very low bioavailability.
2A (laboratory) and 2B (field): Experimental Designs for Studies Are Documented and Appropriate	Experimental design can significantly influence the quality of a study. Higher quality studies will use an experimental design sufficiently robust to allow analysis of the test variables and discriminate non-treatment effects.	Scored based on experimental design and methods used for statistical analyses. Scored 2, 1 or 0. Specific criteria used provided in Attachment 3-2 of EPA (2005).
3: Concentration of Test Substance in Soil Is Reported	The concentration of the contaminant tested must be reported unambiguously.	Scored 2 if measured concentrations were reported. Scored 1 for nominal concentrations and scored 0 in all other cases.

Table 2-6 Summary of Nine Study Evaluation and Scoring Criteria for Applicability to Plant and Soil Invertebrate Development of PFAS ESVs

Criterion	Rationale	Scoring
4: Control Responses Are Acceptable	Negative controls are critical to distinguish treatment effects from non-treatment effects.	Scored 2 if a standardized procedure were used and control values were within procedural guidelines or acceptable range (if non-standard procedure used). Scored 1 if results of control were not reported or were ambiguous. Scored 0 if control results were not within an acceptable range.
5: Chronic or Life Cycle Test Was Used	Chronic toxicity tests assessing long-term adverse sub-lethal impacts on the life-cycle phases of an organism are considered superior to acute toxicity tests.	Scored 2 if chronic exposures were used. Scored 1 if acute tests were used. Scored 0 if very short-term exposures were used.
6: Contaminant Dosing Procedure Is Reported and Appropriate for Contaminant and Test	Contaminant dosing procedure may affect the outcome of a test. Dosing procedure should include: (A) the form of the contaminant; (B) the carrier or vehicle (e.g., solvent, water); (C) how the carrier was dealt with following dosing (i.e., allowed to volatilize, controls); (D) procedure for mixing of soil with contaminant (homogeneity).	Score applied based on how well the study reports the four contaminant dosing procedures (A to D). Scored 2 if study reported all. Scored 1 if information for items A and B, but not C or D; Scored 0 if details were not provided and could not be inferred.
7: A Dose-Response Relationship Is Reported or Can Be Established from Reported Data	Two methodologies can be used to identify this benchmark concentration. The first method generates a NOAEC and a LOAEC. The second method uses a statistical model to calculate a dose-response curve and estimate an effect concentration for some percentage of the population (EC_x), usually between EC_5 and EC_{50}.	Scored 2 if an EC10- EC20; or a NOEC and LOEC were within a factor of 3. Scored 1 if the difference between the NOEC and LOEC was > 3× but < 10×. Scored 0 if an ECx was not reported or the difference between the NOEC and LOEC was > 10, or only a NOEC or LOEC was reported.

Table 2-6 Summary of Nine Study Evaluation and Scoring Criteria for Applicability to Plant and Soil Invertebrate Development of PFAS ESVs

Criterion	Rationale	Scoring
8: Statistical Tests Used to Calculate the Benchmark and the Level of Significance Were Described	Statistical tests and results reported in the study should be sufficient to determine the significance of the results.	Scored 2 if ANOVA or statistical method were based on a $P = 0.05$; or the 95% CI of the EC_x. Scored 1 if an ANOVA was completed but P level not provided or >0.05; or if EC data did not include the 95% CI or used a 90% CI. Scored 0 if a NOEC, LOEC, or EC/LC_x were not reported, or were reported without a description of the method used to calculate the values.
9: Origin of the Test Organisms Is Described	The results of a toxicity test can be influenced by the condition of the test organisms. Culture conditions should be maintained such that the organisms are healthy and have had no exposure above background to contamination prior to testing (inverts) or detailed information is provided about the seed stock (plants).	Scored 2 if the source and condition of the test organisms were known and described. Scored 1 for a noncommercial source not adequately described, or if insufficient information was provided about a commercial source. Scored 0 if organisms were from a known contaminated site, or insufficient information was provided on the commercial source.

Source: EPA (2005).

For evaluating a candidate study with respect to the bioavailability of PFAS under the study conditions, we will consider the properties of the test soils, as well as the complex sorption behavior of PFAS in soils, owing to their structure composed of an acidic head and a hydrophobic fluorinated hydrocarbon tail. PFAS in the study set, with pK_a values in the range of <2, will be predominantly in anionic, or deprotonated, form at environmental pH.

Most of the other nine Eco-SSL Guidance (EPA 2005) scoring criteria will have already been addressed in the selection and screening of papers, and thus, evaluated papers will tend to score on the high end of the scale. For example, all qualifying studies will have the concentration of test substance in soil reported (Criterion 3). Likewise, study acceptance criteria already address acceptable control responses (Criterion 4).

Scoring each of the nine criteria on a scale of 0, 1, or 2 yields a maximum possible score of 18. Studies will be categorized using total score into one of the following four categories, according to total score:

- Unacceptable
- Low
- Medium
- High

Studies scoring roughly 10 or less would not be included in ESV derivation, as those studies would to be lacking sufficient detail to allow us to evaluate the quality of the data. We expect few if any studies emerging from the study identification process using ECOTOX will score 10 or less. After we have scored all studies, we will bin acceptable studies in a post hoc fashion into one of the remaining low, medium or high categories for assessing and characterizing the overall quality and uncertainty of eventually derived ESVs. If information is not available from published studies to score a particular criterion, we will evaluate overall study quality to assign a qualitative score, including of unacceptable.

2.4.2 Terrestrial Wildlife

2.4.2.1 Wildlife TRVs

Argonne will use the PFAS TRVs developed by USAPHC as they become available. Argonne will derive TRVs for PFAS compounds if not available from USAPHC (Section 4). In identifying literature for use in calculating TRVs, ANL will use the EPA (2005) scoring criteria as a guideline to evaluate key indicators of study quality such as proper experimental design, statistical analysis, and the relevance of endpoint and exposure conditions (Table 2-7). Each scoring criteria can receive a score in the range of 0 to 10 and the final score will be the sum of all 10 criteria scores (100 is the highest score). A total score 66 or higher (66%), as identified in the Eco-SSL Guidance (EPA 2005), will be used as a rough cutoff for acceptable studies for deriving TRVs. As for plants and soil invertebrate studies in the previous section, after all studies have scored, we will bin all acceptable studies into low, medium and high-quality categories for the purpose of evaluating the uncertainty of derived ESVs.

Table 2-7 Summary of Scoring Criteria for Use in Developing Wildlife TRVs for PFAS[a]

Criteria	Scoring Basis	Score
Data Source	Primary source is acquired and reviewed	10
	Primary source is not acquired and reviewed	0
Consideration of Absorption Fraction and Contaminant Form	Contaminant form is known and is the same or similar to the of medium of concern	10
	Contaminant form is irrelevant to absorption or biological activity	10
	Contaminant form is known and is different from that found in the medium of concern	5
	Contaminant form is not reported (this includes situations when the contaminant is just listed as "Lead" or "Selenium")	4
Test Substance Concentrations	Test substance concentrations reported as actual measured values, verified nominal and/or doses administered by gavage	10
	Test substance concentrations reported as nominal values	5
	Test substance concentrations not reported	0
Dose Quantification	Administered doses reported as mg/kg body weight (includes gavage doses reported in these units)	10
	Administered doses need to be calculated and intake rates and body weights provided	7
	Administered doses need to be calculated and only one value (intake or body weight) provided (if study is gavage or another capsule, intake is "provided")	6
	Administered doses need to be calculated based on estimated intake rates and body weights	5
	Administered doses cannot be calculated from the information provided	0
Dose Range	Both NOAEL and LOAEL are identified; values are within a factor of 3	10
	Both NOAEL and LOAEL are identified; values are within a factor of 10	8
	Both NOAEL and LOAEL are identified; values are not within a factor of 10	6
	Only NOAEL or LOAEL is identified	4
	Study lacks a suitable control group	0
Dose Route	Chemical incorporated into food (including mother's milk)	10
	Other oral (gavage, capsule)	8
	Chemical incorporated into drinking water	5
	Not dietary, other oral, or drinking water or not reported or choice of treated and non-treated food or water	0
Endpoint	Reported endpoint is a reproductive or population effect	10

Table 2-7 Summary of Scoring Criteria for Use in Developing Wildlife TRVs for PFAS[a]

Criteria	Scoring Basis	Score
	Reported endpoint is lethality (chronic or subchronic exposures)	9
	Reported endpoint is reduction in growth	8
	Reported endpoint is sublethal change in organ function, behavior or neurological function	4
	Reported endpoint is a biomarker of exposure with unknown relationship to fitness	1
Exposure Duration	Exposure duration encompasses multiple life stages of test species	10
	Exposure duration is at least 0.1 times the expected life span of the test species or occurs during a critical life phase	10
	Exposure duration is shorter than 0.1 times the expected life span of the test species and multiple doses or concentrations are administered	6
	Exposure duration is shorter than 0.1 times the expected life span of the test species and only a single dose or concentration is administered.	3
	Exposure duration is acute or not reported	0
Statistical Power	At least 90% chance of seeing a difference that is biologically significant	10
	NOAEL and LOAEL available or LOAEL only available	10
	At least 75% chance of seeing a difference that is biologically significant	8
	At least 50% chance of seeing a difference that is biologically significant	6
	Less than a 50% chance of detecting a difference that is biologically significant	3
	Only NOAEL available; insufficient data reported to determine statistical power of study	1
Test Conditions	Follows a standard guideline and reports all test parameters	10
	Does not follow a standard guideline, but does report all test parameters	10
	Follows a standard guideline but does not report test parameters	7
	Does not follow a standard guideline and reports some, but not all of the test parameters	4
	Does not report any test parameters	2

[a] In the derivation of the reported ESVs, scoring of wildlife studies was not conducted using the criteria in this table given the study reviews separately conducted by the USAPHC in their development of TRVs for several PFAS, which were adopted, and due to the limited number of studies available for the remaining PFAS.
Source: EPA (2005).

2.4.3 Aquatic Life and Aquatic-Dependent Wildlife

2.4.3.1 Aquatic Life

We will adapt appropriately the criteria in Table 2-7, developed for wildlife TRVs (EPA 2005) to evaluate studies on aquatic life. The criteria in Table 2-7 represent good toxicological practice, independent of exposure media or receptors. Criteria for dose quantification and dose route will be adapted to aquatic exposures. We will apply the same binning process described above to categorize study quality. We will also consider the following guidelines on the collection of data from the Guidance (Stephens et al. 1985):

- Collect all available data on the material concerning (a) toxicity to, and bioaccumulation by, aquatic animals and plants; (b) FDA action levels 12; and (c) chronic feeding studies and long-term field studies with wildlife species that regularly consume aquatic organisms.
- All data that are used should be available in typed, dated, and signed hard copy (publication, manuscript, letter, memorandum, etc.) with enough supporting information to indicate that acceptable test procedures were used and that the results are probably reliable.
- Questionable data, whether published or unpublished, should not be used. For example, data should usually be rejected if they are from tests that did not contain a control treatment, tests in which too many organisms in the control treatment died or showed signs of stress or disease, and tests in which distilled or deionized water was used as the dilution water without addition of appropriate salts.
- Data on technical grade materials may be used if appropriate, but data on formulated mixtures and emulsifiable concentrates of the material of concern should not be used.
- For some highly volatile, hydrolyzable, or degradable materials it is probably appropriate to use only results of flow-through tests in which the concentrations of test material in the test solutions were measured often enough using acceptable analytical methods.
- Data should be rejected if they were obtained using:
    - Brine shrimp, because they usually only occur naturally in water with salinity greater than 35 g/kg.
    - Species that do not have reproducing wild populations in North America.
    - Organisms that were previously exposed to substantial concentrations of the test material or other contaminants.
- Questionable data, data on formulated mixtures and emulsifiable concentrates, and data obtained with non-resident species in North America or previously exposed organisms may be used to provide auxiliary information but should not be used in the derivation of criteria.

2.4.3.2 Wildlife Exposures through Aquatic Pathways

To derive a Tier I wildlife ESVs for aquatic pathways, sufficient toxicity data are needed so that sub-chronic or chronic dose-response curves can be developed for each of the representative mammalian and avian species. The preferred study types used to develop dose-response curves are shown in Table 2-8.

Table 2-8 Criteria for Selecting/Rejecting Data for use in Developing Aquatic ESVs for the Protection of Wildlife

1. Data from peer-reviewed field studies of wildlife species takes precedence over other types of studies.
2. An acceptable field study must be of sub-chronic or chronic duration, provide a defensible, chemical-specific dose-response curve in which cause and effect are clearly established, and assess acceptable endpoints (reproduction, growth, and mortality).
3. If acceptable wildlife field studies are not available, the necessary toxicity information may come from peer-reviewed laboratory studies
4. To reduce uncertainties in making interspecies extrapolations, when laboratory studies are used preference will be given to laboratory studies with wildlife species rather than traditional laboratory animals.
5. All available laboratory data and field studies will be reviewed to assess the reasonableness of the toxicity value used, and the appropriateness of any uncertainty factors (UFs) that were used in the studies.
6. The mammalian data must come from at least one well-conducted study of 90 days or greater and designed to observe sub-chronic or chronic effects as defined in this document
7. The avian data must come from at least one well-conducted study of 70 days or greater and designed to observe sub-chronic or chronic effects as defined in this document
8. Studies involving exposure routes other than oral will be considered but only if an equivalent oral daily dose can be estimated and technically justified
9. Preference will be given to studies assessing effects on developmental or reproductive endpoints.

Source: EPA (1995a)

The Technical Support Document for developing wildlife criteria for the Great Lakes (EPA 1995b) provides additional discussion on the selection of appropriate toxicity studies.

2.5 References

Deck, A.T., and M.S. Johnson. 2015. "Methods for Derivation of Wildlife Toxicity Values for Use in Ecological Risk Assessments," Chapter 2 in: *Wildlife Toxicity Assessments for Chemicals of Military Concern* (M. Williams et al., eds.). Elsevier, Waltham, MA.

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EPA. 2005. *Guidance for Developing Ecological Soil Screening Levels*. Washington, DC: U.S. Environmental Protection Agency. OSWER Directive 9285.7-55.

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Stephen, C.E., D.I. Mound, D.J. Hansen, J.R. Gentile, G.A. Chapman, and W.A. Brungs. 1985. *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*. PB85-227049. Prepared by U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratories, Duluth, MN.

3 DERIVATION OF SOIL ESVs FOR TERRESTRIAL PLANTS AND SOIL INVERTEBRATES

3.1 Data Extraction and Scoring

Section 2 of this report describes the process and acceptance criteria that will be used to identify potentially acceptable studies for developing screening levels. For toxicology studies that meet our ESV acceptance criteria (Table 2-5), we will extract and score toxicity data for both plants and soil invertebrates following the process outlined in Section 2.4.1, which is based on EPA's Eco-SSL guidance (EPA 2005). Soil concentrations will be converted, if necessary, to a dry weight using reported soil moisture content; PFAS concentrations will be based on the molecular weight of the PFAS acids, not on that of a salt, if used in studies.

3.2 Derivation of ESVs

We will compute ESVs for both plants and soil invertebrates as the geometric mean of the toxicity values selected from qualifying studies, a calculation which requires a minimum of three values. We will give preference to studies in natural soil with the highest bioavailability for PFAS. If only one or two qualifying studies are available, we will use the single value or arithmetic mean, respectively.

We will evaluate bioavailability of PFAS in soils based loosely on Eco-SSL Guidance, Attachment 3-2 (EPA 2005), which accounts for soil pH and sorbate (PFAS) sorption constants (Log Koc). The derivation will use the preferred toxicity values: EC_{20}, MACT (bounded LOAEL/NOAEL), and EC_{10} (Section 2.4.1.2).

3.3 References

EPA (U.S. Environmental Protection Agency). 2005. *Guidance for Developing Ecological Soil Screening Levels*. Washington DC: U.S. Environmental Protection Agency. OSWER Directive 9285.7-55.

4 DERIVATION OF SOIL ESVs FOR WILDLIFE

Methods for deriving soil based PFAS ESVs for wildlife generally follow EPA guidance for developing ecological soil screening levels (EPA 2005). This section describes methods and assumptions that will be used to develop soil based PFAS ESVs for wildlife including:

1. Wildlife ingestion models for estimating exposure to wildlife from PFAS compounds in soil (Section 4.1);
2. Derivation of wildlife TRVs for PFAS compounds (Section 4.2); and
3. Identification of soil based PFAS ESVs for wildlife (Section 4.3)

Section 2 of this report describes our process and acceptance criteria for identifying potentially acceptable studies for developing the soil ESVs for wildlife.

4.1 Wildlife Ingestion Exposure Modeling

Modeling to estimate wildlife exposure doses will be consistent with methods described in EPA's guidance for developing ecological soil screening values for wildlife (EPA 2005).

4.1.1 Calculation of Ingestion Exposures

The general equation that will be used for estimating soil-based contaminant exposure to wildlife through ingestion of food items and incidental soil ingestion is:

$$\mathrm{ED}_j = \left(\left[\mathrm{Soil}_j * P_s * \mathrm{FIR} * \mathrm{AF}_{js}\right] + \sum_{i=1}^{N}\left[B_{ij} * P_i * \mathrm{FIR} * \mathrm{AF}_{ij}\right]\right) * \mathrm{AUF} \qquad \text{(Equation 4-1)}$$

where:

ED_j	=	Ingestion dose for contaminant (*j*) (milligram contaminant per kilogram organism bodyweight per day),
Soil_j	=	Concentration of contaminant (*j*) in soil (mg/kg dry weight),
N	=	Number of different biota types in diet (see Table 4-1),
B_{ij}	=	Concentration of contaminant (*j*) in biota type (*i*) (mg/kg dry weight) (see Section 4.1.3),
Pi	=	Proportion of biota type (*i*) in diet (value from 0 to 1) (see Table 4-1),
FIR	=	Food ingestion rate (kilogram food [dry weight] per kilogram organism bodyweight [wet weight] per day) (see Table 4-1),
AF_{ij}	=	Absorbed fraction of contaminant (*j*) from biota type (*i*) (for screening purposes set equal to 1),
AF_{js}	=	Absorbed fraction of contaminant (*j*) from soil (*s*) (for screening purposes set equal to 1),
P_s	=	Soil ingestion as proportion of diet (see Table 4-1),
AUF	=	Area use factor (for screening purposes set equal to 1).

Using this equation, exposure from incidental soil ingestion is added to the total dietary (food-based) exposure, resulting in a total oral exposure greater than 100%. This equation includes

terms for the absorbed fraction (AF) of the contaminant from soil and the diet as well as an area use factor (AUF) that represents the fraction of time an animal would be exposed); for calculation of PFAS ESVs, which are intended to be conservative screening values, AF and AUF are set equal to 1. Although some ecological risk assessments consider seasonal changes in proportions of food items in the diet by applying seasonal use factors (SUFs), this will not be considered in development of PFAS wildlife screening values (i.e., SUF would be equal to 1 for all diet items).

The concentration of contaminants in specific types of biota eaten in the diet will be estimated as described in Section 4.1.3.

4.1.2 Selection of Surrogate Wildlife Receptors

Consistent with EPA Eco-SSL Guidance for developing ecological soil screening values (EPA 2005), surrogate species will be used to derive the soil based PFAS wildlife ESVs. These surrogate species are considered to be representative of other species within the same class (mammalian or avian) that have similar diets.

The purpose of focusing on representative species within generic trophic groups is to develop a set of generic screening values that would be protective of the great majority of species present at any site, regardless of the presence or absence of a particular species. The trophic groups for which screening levels will be developed are expected to be present or potentially present at most sites where PFAS ESVs will be applied. Applying this approach will provide results useful for comparing risks associated with different exposure routes (e.g., ingestion of food versus ingestion of soil) and different contaminant transport pathways (e.g., soil to herbivore, soil to ground insectivore, soil to soil invertebrate, and soil to plant). In addition, the use of surrogate receptors is consistent with *Ecological Risk Assessment Guidance for Superfund* (ERAGS), which states: “for the screening-level ERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments” (EPA 1997).

Consistent with the Eco-SSL guidance (EPA 2005), herbivore, ground insectivore, and carnivore trophic groups for both mammals and birds will be used for the PFAS ESV wildlife exposure models. Within each of these trophic groups, uptake for a surrogate species will be modeled in order to provide a conservative representation for their respective trophic groups. These species (Table 4-1) are generally small in size relative to other species within their respective trophic groups. Because small size is generally associated with higher metabolic rates and smaller home ranges, exposure for small receptors on a bodyweight basis is assumed to be high and ESVs based on these species are likely to be protective of larger species of mammals and birds in the same trophic groups (EPA 2005).

Table 4-1 Surrogate Wildlife Receptors and Exposure Model Parameters for Developing Soil-Based PFAS ESVs[a]

Receptor Group (Surrogate Species)	Assumed Diet	Food Ingestion Rate[b] (FIR, kg dw/kg bw/ day)	Soil Ingestion[c] (P_s)
Mammalian Herbivore (Meadow Vole)	100% foliage	0.0875	0.032
Mammalian Ground Invertivore[d] (Short-tailed shrew)	100% earthworms	0.209	0.030
Mammalian Carnivore (Long-tailed weasel)	100% small mammals	0.130	0.043
Avian Granivore (Mourning dove)	100% seeds	0.190	0.139
Avian Ground Invertivore (American woodcock)	100% earthworms	0.214	0.164
Avian Carnivore (Red-tailed hawk)	100% small mammals that consume 100% earthworms	0.0353	0.057

[a] Source: EPA (2005).
[b] High end point estimate based on measured data (see EPA 2005, Attachment 4-1, for derivation).
[c] Soil ingestion as proportion of diet (see EPA 2005, Attachment 4-1, for derivation); dw = dry weight.
[d] Uptake for insectivores will be estimated in the models by assuming earthworm prey.

Table 4-1 presents the surrogate species upon which soil-based PFAS ESVs for wildlife will be based, along with the assumed diets and food and soil ingestion rates for parameterizing the associated wildlife exposure models. Included are three mammalian and three avian species that are intended to represent highly exposed species. It is assumed that identification of ESVs for these six species will also be protective of other species of herbivores, ground invertivores, and carnivores (EPA 2005). FIRs for modeling contaminant uptake by surrogate wildlife receptors, as identified in Table 4-1, are values identified in the Eco-SSL Guidance (EPA 2005); those values were based on typical and high-end food intake rates for each of the surrogate species and were compiled from the Wildlife Exposure Factors Handbook (EPA 1993) and from other available sources.

4.1.3 Estimating Contaminant Concentrations in Dietary Items

Concentrations of PFAS compounds in biota serving as food items (B_{ij}; Equation 4-1) in wildlife diets (plants, earthworms, or small mammals as indicated in Table 4-1) will be estimated by assuming that the concentration of compound *j* in food type *i* can be predicted from the concentration of the contaminant in the soil ($Soil_j$; Equation 4-1). However, the nature of the relationship between soil concentrations and the resulting tissue concentrations in organisms is not always proportional to soil concentrations (see, e.g., Sample et al. 2014) and can take a variety of forms, including constant, log-linear, or linear (EPA 2005).

Recognizing this, the estimation of the concentration of PFAS compounds in tissues of prey organisms will be estimated using a hierarchical decision process described in the Eco-SSL Guidance (EPA 2005). Thus, in order of preference, the tissue concentration values in prey items will be derived using:

1. Existing regression equations identified from the literature;
2. New regression equations developed using paired data pertaining to contaminant concentrations in tissues relative to (a) concentrations in soil (for invertebrate and plant food items) or (b) relative to concentrations in food eaten by small mammals that are then prey for mammalian or avian receptors);
3. Ratios of contaminant in soil to contaminant in food items (i.e., bioaccumulation factors, BAFs) from the literature or from paired data identified during attempts to develop new regressions (item 2, above); or
4. Other assumptions about bioaccumulation of contaminants from soil into tissues of food items.

4.2 Derivation of Wildlife TRVs

For the development of ecological soil screening values, the EPA (2005) defines a wildlife TRV as follows:

> *Dose above which ecologically relevant effects might occur to wildlife species following chronic dietary exposure and below which it is reasonably expected that such effects will not occur.*

Thus, wildlife TRVs are derived estimates of threshold levels above which chemical doses or concentrations result in adverse effects on wildlife species (Allard et al. 2010). In practice, TRVs are compared to calculated or measured chemical exposure estimates for specific sites to determine whether wildlife species may be adversely affected. In most cases, chemical-specific TRVs for avian and mammalian wildlife are derived from, and compared to, oral exposure estimates in order to predict the potential for adverse effects on avian and mammalian wildlife (Allard et al. 2010).

Derivation of PFAS TRVs for wildlife will follow technical guidance developed by U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM 2000). USAPHC is currently in the process of developing draft wildlife TRVs for some PFAS compounds following this process and, unless there is a clear need to update these values, wildlife TRVs for PFAS compounds developed by the USAPHC will be adopted directly in the derivation of soil ESVs.

Three principal approaches are used to develop TRVs for wildlife, in descending order of preference: (1) the benchmark dose approach, (2) the NOAEL/LOAEL approach, and (3) the approximation approach (Williams et al. 2015; USACHPPM 2000). For the derivation of PFAS TRVs for wildlife, the benchmark dose approach will be preferred as long as adequate information is available to apply this method, which is the most data intensive of the three. In cases where insufficient data are available for developing benchmark doses, the

NOAEL/LOAEL approach, followed by the approximation dose approach will be applied, according to data availability. For some PFAS compounds, there may be insufficient or inadequate data for development of TRVs using any of these methods. Sections 4.2.1 through 4.2.3 describe methods and assumptions for identifying PFAS wildlife TRVs using these three approaches.

Under all three approaches, low and high TRV values will be identified to bracket the range between exposure levels at which no observed adverse effects are expected to occur and levels at which adverse effects are expected to begin to occur.

4.2.1 Benchmark Dose Approach

The benchmark dose approach refers to the use of dose–response relationships to identify specific benchmarks or thresholds of effects to be used as the basis for developing TRVs (Mayfield and Skall 2018; Williams et al. 2015; USACHPPM 2000; EPA 2012).

The benchmark dose approach fits curves to dose-response data from the available relevant toxicity data and endpoints and takes variation in the measurement of endpoints into account (EPA 2012; Mayfield and Skall 2018). Preferred endpoints will be those that are considered relevant to population level effects (USACHPPM 2000) and biologically significant (Mayfield and Skall 2018). Endpoint variation is captured by identifying low and high TRV estimates for each representative wildlife receptor-toxicant combination. When possible, the low-value TRV will be based on the lower 95% confidence interval for a 10% effect level (i.e., a dose about which there is 95% confidence that 10% or fewer animals are expected to exhibit an adverse effect) as described in USACHPPM (2000). Alternatively, low-TRV values can be based on the lower 95% confidence level based on one standard deviation from the control mean if suitable ranges of values are not available for a particular test species (Mayfield and Skall 2018). Depending on the available data derived from suitable studies, the high-value TRVs for avian and mammalian wildlife species will be calculated as either (1) the dose that corresponds to the estimated 10% population effect level or (2) as the value on the best-fit dose-response curve that represents the threshold level where adverse effects would be expected. TRVs that specifically consider assessment endpoints related to mortality, reproduction, or growth for avian and mammalian wildlife will be developed.

Use of the benchmark dose approach is preferred because it considers all the suitable data available for a specific endpoint from relevant studies and plots a best-fit dose-response function that can most reliably identify a concentration that results in a threshold-level of unacceptable effects. However, development of wildlife TRVs using dose–response relationships can be challenging because datasets available for examining a variety of exposure levels and species are limited (Mayfield and Skall 2018), especially for emerging contaminants such as PFAS.

As described in the following sections, the principal steps for identifying a benchmark dose include:

1. Data evaluation, which includes the selection of studies and endpoints for developing benchmark dose calculations;
2. Identification of a benchmark response (BMR) value; and
3. Selecting, assessing, and running the appropriate model(s) to compute the benchmark dose and associated confidence limits.

4.2.1.1 Evaluation of Data

The EPA has not developed specific guidance for use of the benchmark dose modeling for derivation of TRVs for wildlife. However, the process of developing benchmark doses for wildlife TRVs can be informed by technical guidance developed for application to human health risk assessments (EPA 2012), as well as frameworks specific to developing wildlife TRVs (e.g., Mayfield and Skall 2018; Mayfield et al. 2014). The first step is to evaluate whether the available data are adequate for developing benchmark doses for the PFAS compounds of concern, appropriate wildlife species, and ecologically relevant endpoints related to mortality, reproduction, or growth for relevant wildlife species. Steps followed to evaluate the feasibility of conducting benchmark dose modeling for PFAS effects on wildlife will be consistent with recommendations provided by EPA (2012), as shown in Figure 4-1.

Studies involving multiple dose groups and exhibiting a graded monotonic response with dose will generally be most useful for benchmark dose analysis. Studies that identify only a single dose level that elicits a response compared to controls will generally not support benchmark dose analysis, although there may be exceptions (EPA 2012). Studies with one or multiple doses near the BMR level are preferable for estimating benchmark doses.

Selection of studies for benchmark dose analysis will be based on the quality of the studies, the adequacy of the results and data reported in the study, and the ecological relevance of the endpoints examined in the study. The process of selecting and scoring studies will ultimately determine whether sufficient high-quality data are available for benchmark dose analysis for wildlife species for specific PFAS compounds. All the suitable relevant studies will be considered for dose-response modeling. Combining several datasets may be an option when the datasets are determined to be statistically and biologically compatible (see EPA 2012 for additional information).

Ecologically relevant endpoints related to mortality, reproduction, or growth from studies judged to provide suitable datasets will be considered for modeling. This will help ensure that no sensitive endpoints are excluded from the analysis. The EPA (2012) recommends that, at a minimum, datasets used for benchmark dose modeling should: (1) establish statistically

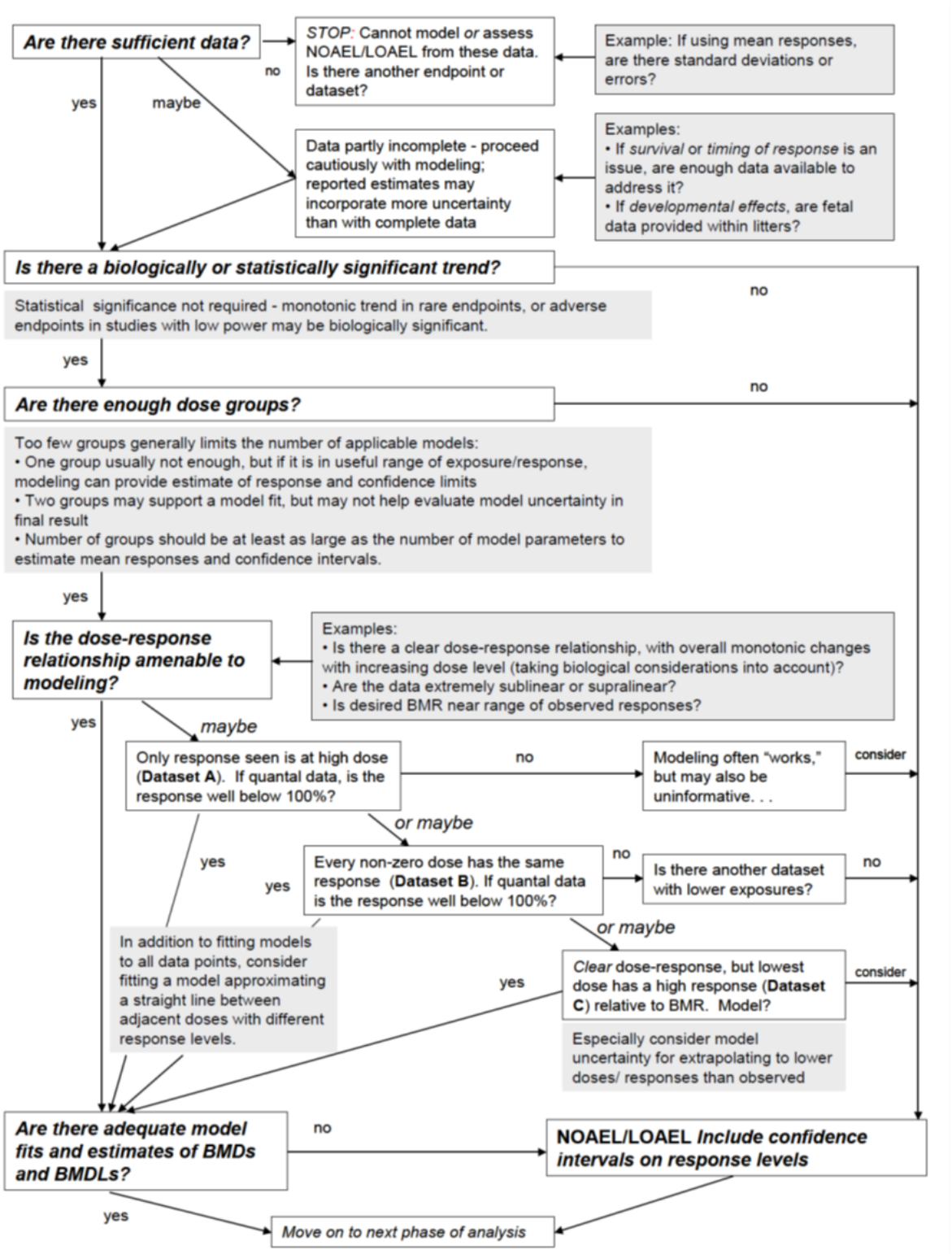

Figure 4-1 Steps for Evaluating Data Suitability and Feasibility of Benchmark Dose Modeling (source: EPA 2012). Datasets A, B, or C refer to examples illustrated in EPA (2012), Figure 2B.

or biologically significant dose-related trends for the selected endpoints and (2) contain information about the dose-response relationship that fall between the control level and the maximal response level.

4.2.1.2 Identification of a BMR Value

The BMR value is defined as a predetermined change in the response rate of an adverse effect relative to the background response rate of the effect. The BMR value identifies the level of change from the background response that represents an adverse effect when calculating benchmark doses and when calculating lower and upper confidence limits (BMDLs and BMDUs, respectively) for the calculated benchmark doses. For the purposes of identifying benchmark doses for PFAS TRVs for use in developing soil ESVs, a default response level of 10% will be selected for each of the assessment endpoints (mortality, reproduction, or growth) for the wildlife species, especially birds and mammals. This would result in identification of a TRV range that extends from an ED_{10} at the upper bound to the lower 95% confidence limit of the ED_{10} as the lower bound. Under these benchmarks, it would be anticipated that 90% of individuals in an exposed population will not experience adverse effects at exposures at the estimated benchmark dose level (USACHPPM 2000). Specific statistical approaches may be adopted during analysis based on further discussions with the interagency work group.

4.2.1.3 Modeling the Benchmark Dose

Determining a benchmark dose involves fitting a mathematical model to dose-response data in a manner that most adequately describes the dataset, especially at the lower end of the observable dose-response range. Such mathematical fitting of the dose-response relationships allows estimates of uncertainty associated with doses corresponding to the identified BMR (Section 4.2.1.2). In practice, this procedure involves selecting a family (or families) of models for consideration, based on characteristics of the data and experimental design, and fitting the models using one of a few established methods. Various considerations for model selection, model fitting, assessing how well the calculated models describe the data, improving model fit, comparing models, and calculating confidence limits to obtain a BDML are presented in EPA (2012) and Mayfield and Skall (2018).

The EPA's Benchmark Dose Software (BMDS; EPA 2018) may be used to conduct benchmark dose modeling for identifying PFAS wildlife TRVs. EPA developed the BMDS (currently BMDS version 3.0; EPA 2018) as a tool to facilitate the application of benchmark dose methods to hazardous pollutant risk assessments; BMDS is consistent with the EPA's Benchmark Dose Technical Guidance Document (EPA 2012, 2018). BMDLs and benchmark doses derived using the benchmark dose approach will be used as the preferred low- and high-range TRVs (functionally equivalent to NOAELs and LOAELs, respectively) for the development of PFAS soil ESVs as described in Section 4.4.

4.2.2 NOAEL/LOAEL Approach

The NOAEL/LOAEL approach uses NOAEL and LOAEL values from relevant studies pertaining to ecologically relevant endpoints for the wildlife groups of interest to determine the TRV values for each chemical of concern (USACHPPM 2000).

As described in the following sections, the principal steps for identifying TRVs from NOAEL/LOAEL information include:

1. Identify studies that contain adequate data for applying the NOAEL/LOAEL approach for the contaminants, endpoints, and wildlife groups of interest;
2. Extract NOAEL and LOAEL values from the relevant studies and segregate and plot the values according to contaminants, endpoints, and wildlife groups; and
3. Derive LOAEL-based and NOAEL-based TRVs from extracted or plotted data.

4.2.2.1 Evaluation of Data

The toxicological literature identified from the literature search as described in Section 2 will be reviewed for applicability to establishing wildlife TRVs for PFAS compounds. As with the benchmark dose approach, the NOAEL/LOAEL approach will use chronic studies, not acute or subacute toxicity studies (i.e., studies with exposures of 3 days or less in duration). By excluding acute toxicity data, the developed TRVs will identify doses protective of most species from adverse effects associated with long-term exposures and sublethal reproductive and growth effects (EPA 2005). Chronic studies include exposure durations of sufficient length to reveal most adverse effects that will occur, or would be expected to occur, over the lifetime of an exposed organism (EPA 1985).

TRVs will be developed using all the relevant toxicological data from appropriate studies; use of a single study will be avoided. In addition, wildlife TRVs will only be derived from oral dose response data because such data are more relevant to establishing soil screening levels that will be protective of potential exposures from ingestion of soil or food. Following Eco-SSL Guidance (EPA 2005), the required dataset will consist of at least three NOAEL or LOAEL results for at least two test species for either growth, reproduction or mortality effects.

Attachment 4-4 of the Eco-SSL Guidance (EPA 2005) provides a data evaluation scoring system based on 10 attributes of evaluated toxicological studies. This scoring system will be adopted for the development of PFAS soil ESVs. Any study endpoints receiving a total data evaluation score of 65 or less of a possible 100 will not be used to derive TRVs.

4.2.2.2 Sorting and Plotting Toxicological Data

NOAEL and LOAEL data extracted from relevant studies will be depicted in summary plots for each of the target PFAS compounds sorted by endpoints relevant to mortality, reproduction, and growth; mammalian and avian toxicological data will be presented on separate plots. Attachment 4-5 of the Eco-SSL Guidance (EPA 2005) provides examples of summary plots.

Such plots allow comparisons of the relative results for different species, as well as results from the same study.

4.2.2.3 Deriving TRVs

Following the USAPHC guidance (USACHPPM 2000), the minimum dataset for deriving a wildlife TRV using the NOAEL/LOAEL approach consists of (1) three studies of sufficient quality addressing relevant endpoints (Table 2-2), which collectively provide data for three or more species within a taxonomic class; (2) data for at least two different taxonomic orders; and (3) at least two chronic LOAELs and at least one chronic NOAEL. Relevant effects relate to population sustainability and include mortality, reproduction, development, and growth. If these minimum dataset requirements are met for the wildlife group of interest, then the PFAS-specific wildlife TRVs will be selected from the relevant studies using the NOAEL/LOAEL TRV derivation process identified in the same guidance (USACHPPM 2000). The LOAEL-based TRV will be the lowest documented LOAEL from the chronic mortality, reproduction, or growth endpoints. The NOAEL-based TRV will be selected from the highest NOAEL that is lower than the selected LOAEL within the same endpoint group as the selected LOAEL. If a NOAEL from the same endpoint is unavailable, then the highest NOAEL that is less than the selected LOAEL within all relevant endpoints will be selected as the NOAEL-based TRV.

4.2.3 Approximation Approach

The approximation approach will be used if the minimum data requirements for either the benchmark dose or NOAEL/LOAEL are not met (USACHPPM 2000). When the requirements are not satisfied, the available toxicity data are insufficient to characterize toxicity for a class of animals (i.e., mammals or birds) with an appropriate degree of certainty. In such cases, uncertainty factors will be applied to develop TRVs until more toxicity data are available.

The most relevant and reliable study in terms of quality and applicability will be used to approximate TRVs from the NOAEL and LOAEL for a given PFAS. These TRVs will be derived by dividing the NOAEL and LOAEL of interest by an appropriate uncertainty factor. When multiple uncertainty factors are required, the NOAEL and LOAEL will be divided by the product of the uncertainty factors. Extrapolation from a single study or from data that may be unreliable given an understanding of the study design (e.g., power of the statistical comparisons) may not be appropriate. Professional judgment will determine whether development of TRV approximations from limited data is justified.

The uncertainty factors that are applied to develop TRVs using this approach account for potential differences in responses due to (1) species-specific differences, (2) differences in exposure duration (e.g., acute versus chronic exposures), and (3) differences in endpoints (e.g., lethality versus non-lethal effects). A general uncertainty factor of 10 will be used to account for potential interspecies differences for the development of TRVs for wildlife. Table 4-2 presents additional uncertainty factors compiled by USAPHC (USACHPPM 2000) to account for differences in test exposure duration and endpoint, which will be applied as appropriate.

Table 4-2 TRV Uncertainty Factors to Account for Differences in Response Due to Exposure Duration and Endpoint

	Uncertainty Factor Used to Develop TRV	
Type of Data Available	**NOAEL-based TRV**	**LOAEL-based TRV**
Chronic NOAEL	1	NA[a]
Chronic LOAEL	10	1
Subchronic LOAEL	10	NA
Subchronic LOAEL	20	4
Acute NOAEL	30	NA
Acute LOAEL	50	10
LD_{50}	100	20

[a] NA = not appropriate.
Source: USACHPPM (2000).

4.3 Derivation of Wildlife ESVs

The basic equation for estimating potential risks to wildlife from contaminant exposure is:

$$Hazard\ Quotient\ (HQ) = \frac{Exposure\ Dose\ (\frac{mg}{kg\ bw}/day)}{TRV\ (\frac{mg}{kg\ bw}/day)} \qquad \text{(Equation 4-2)}$$

where both the calculated exposure dose (see Section 4.1) and the TRV (Section 4.2) are expressed in the same units (i.e., milligrams of contaminant per kilogram of organism bodyweight per day). Using this relationship, the soil-based wildlife ESVs for PFAS compounds will be calculated as the soil concentration that results in a HQ = 1 (i.e., when the contaminant-specific TRV and exposure dose are equal). After setting the parameters for AF_{ij}, AF_{sj}, and AUF in the exposure dose equation (Equation 4-1) to 1, this relationship can be expressed as:

$$\mathrm{HQ}_j = \frac{[(\mathrm{Soil}_j * P_s * \mathrm{FIR}) + \sum_{i=1}^{N}[B_{ij} * P_i * \mathrm{FIR}]]}{\mathrm{TRV}_j} \qquad \text{(Equation 4-3)}$$

Where:

HQ_j = Hazard quotient for contaminant (*j*) in soil;

FIR = Food ingestion rate (kilogram food [dry weight] per kilogram organism bodyweight [wet weight] per day);

$Soil_j$ = Concentration of contaminant (*j*) in soil (mg/kg dry weight);

P_s = Soil ingestion as proportion of diet;

Pi = Proportion of biota type (*i*) in diet;

B_{ij} = Concentration of contaminant (*j*) in biota type (*i*) (mg/kg dry weight); and

TRV_j = TRV for contaminant (*j*) (mg [dry weight]/kg bodyweight [wet weight]/day).

In addition, note that summation of the contribution of multiple diet items to ingestion exposure that is indicated in Equation 4-3 will not be necessary when the assumed diets of the modeled surrogate wildlife receptors consist of single types of food items as identified in Table 4-1 (and P_i in Equation 4-3 = 1). The general procedure for calculating the wildlife ESV for a contaminant (j) will be to solve Equation 4-3 to determine the concentration in soil ($Soil_j$) that results in an HQ_j equal to 1; that soil concentration will be identified as the soil ESV for wildlife. This process will be used to identify ESV values for each of the target PFAS compounds for each mammalian and avian wildlife receptor identified in Table 4-1. The final wildlife ESV for a specific PFAS compound, which is intended to be protective of all mammal and bird species, will be identified using the lowest of the species-specific ESVs for the PFAS compound.

4.4 References

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5 DERIVATION OF AQUATIC ESVs

The derivation of aquatic PFAS ESVs for the protection of aquatic biota and wildlife involves evaluation of available data for data quality and applicability, then using the applicable data to develop screening values. The methods to be used to develop the PFASs ESVs are based on in part, and consistent with, EPA methods for deriving numerical water concentrations for the protection of aquatic biota (Stephen et al. 1985; EPA 1995a). Similar approaches have been used by others to identify aquatic PFAS ecological screening values (e.g., Giesy et al. 2010; Salice et al. 2018).

A two-tiered (Tiers I and II) methodology will be employed to derive acute and chronic freshwater and marine ESVs, using data from multiple taxonomic groupings. This methodology is based on the 1995 Great Lakes Initiative methodology for aquatic life criteria (EPA 1995a), which itself is based on the EPA methodology for deriving national water quality criteria (Stephen et al. 1985). The Tier I methodology is based in part on the methodology for deriving national water quality criteria and requires a specific level and type of data. If sufficient data are not available, a Tier II methodology will be used to derive the screening levels. As the Tier II approach includes greater levels of uncertainty (due to reduced data availability), it will likely result in more stringent screening level.

Depending on data availability, two types of PFAS-specific ESVs may be developed under each tier: a maximum screening level (for acute exposure) and a continuous screening level (for chronic exposure). During a screening risk assessment, a surface water PFAS concentration can be compared to the ESV for that specific PFAS, and further evaluation (i.e., a baseline risk assessment) or site management would be indicated if the ESV is exceeded. Both methodologies are described below.

5.1 Development of a Tier I PFAS ESV

In the Tier I approach, PFAS-specific final acute and chronic toxicity values are developed, and these are then used to derive ESVs that represent maximum and continuous screening levels for the target PFAS compound (Figure 5-1). The Tier I methodology uses:

1. Acute and, if available, chronic toxicity tests meeting data requirements addressing eight or more families of aquatic animals;
2. Acute–chronic ratios for the different families and species, if sufficient chronic data are not available, and
3. At least one acceptable test with an algae or vascular plant.

The toxicity tests will target endpoints corresponding to severe adverse impacts to the exposed test organisms related to survival, growth, and reproduction. The acute toxicity test endpoints related to survival, loss of equilibrium, or immobilization (Stephen et al. 1985; EPA 1995a), while endpoints for the chronic tests will target survival, growth, and reproduction.

Specific data needs for deriving freshwater and marine ESVs are listed in Table 5-1. If available, these PFAS-specific data will be used to derive final acute and chronic values (FAV and FCV, respectively) which, in turn, will serve as the basis for deriving the ESV values (Figure 5-1).

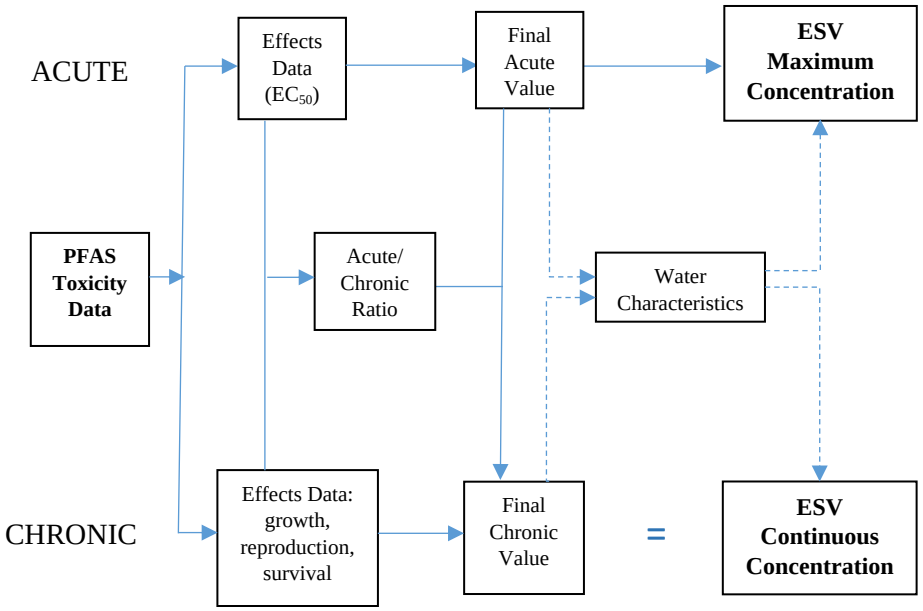

Figure 5-1 Process for Developing PFAS-specific ESVs for Aquatic Biota. (modified from EPA 2015).

Table 5-1 Data Requirements for Development of PFAS-specific ESVs[a]

Data Need	Freshwater ESV	Marine ESV
Acceptable acute and if available chronic toxicity test for the target biota	Minimum of one species in at least eight different families, such that all of the following are included: • The family Salmonidae; • Another family in the class Osteichthyes; • A family in the phylum Chordata; • A planktonic crustacean; • A benthic crustacean; • An insect; • A family in a phylum other than Arthropoda or Chordata; and • A family in any order of insect or any phylum not already represented	Minimum of one species in at least eight different families, such that all of the following are included: • Two families in the phylum Chordata; • A family other than Arthropoda or Chordata; • Either the Mysidae or Penaeidae family; • Three other families not in Chordata (may include Mysidae or Penaeidae, whichever has not yet been used; and • Any other family.
Acute–chronic ratio if sufficient	For species in at least three different families, provided that one of the three species are:	For species in at least three different families, such that the three species are:

Table 5-1 Data Requirements for Development of PFAS-specific ESVs[a]

Data Need	Freshwater ESV	Marine ESV
chronic data are not available	• At least one fish; • At least one invertebrate; and • At least one is an acutely sensitive freshwater species[b]	• At least one is a fish; • At least one is an invertebrate; and • At least one is a sensitive species[c]
Acceptable algae or plant acute test	With a freshwater alga or vascular plant. • If the plant is among the most sensitive test organisms, a plant from another phylum should be used.	With a saltwater alga or vascular plant. • If the plant is among the most sensitive test organisms, a plant from another phylum should be used.

[a] Based, in part, on methods in Stephen et al. (1985) and EPA (1995a).
[b] The other two may be saltwater species.
[c] The other two may be freshwater species.
[d] If a maximum permissible tissue concentration is available.

5.1.1 Developing a Final Acute Value

The PFAS-specific final acute value (FAV) is the estimated short-term PFAS exposure concentration deemed protective of approximately 95% of the tested genera and is used to derive the PFAS-specific ESV acute exposure level. Calculation of the FAV requires acute toxicity data for one or more species meeting data requirements for at least eight families of fish and aquatic invertebrates (Table 5-1). The FAV is calculated as the genus mean acute values (GMAVs) for all genera with suitable toxicity data.

The GMAV is calculated using the species mean acute value (SMAV) for all the species evaluated in a particular genus. The SMAV will be calculated in one of two ways:

- As the geometric mean[1] of the results of all acceptable flow-through acute toxicity tests using the most sensitive life stage of the tested species and in which the PFAS concentrations were measured; or
- If such toxicity data are not available, the SMAV will be calculated as the geometric mean of all acceptable acute toxicity tests with the most sensitive tested life stage.

Once the SMAVs are calculated, the GMAV of a particular genus is calculated as the geometric mean of all the SMAVs derived for each species within that genus.

To calculate the FAV, the GMAVs developed for all the genera will be ordered from low to high and assigned a rank, *R*, from lowest to highest. If two or more GMAVs are identical, they will be

[1] The geometric mean of *N* numbers is the *N*th root of the product of the *N* numbers. Alternatively, the geometric mean can be calculated by adding the logarithms of the *N* numbers, dividing the sum by N, and taking the antilog of the quotient. The geometric mean of two numbers is the square root of the product of the two numbers, and the geometric mean of one number is that number.

assigned successive ranks. Next, each GMAV will be assigned a cumulative probability score (*P*), calculated as:

$$P = \frac{R}{(N+1)} \qquad \text{(Equation 5-1)}$$

Where:

P = cumulative probability score of the GMAV;

R = the GMAV rank (from 1 to *N*); and

N = number of GMAVs in the ranked dataset.

Next, the four GMAVs with cumulative probabilities closest to 0.05 (typically the four lowest GMAVs if fewer than 59 GMAVs are available) will be selected, and together with their probabilities will be used to calculate the PFAS-specific FAV, as follows:

$$S^2 = \frac{(\sum(\ln \text{GMAV})^2) - \frac{(\sum \ln \text{GMAV})^2}{4}}{\sum(P) - \frac{(\sum(\sqrt{P}))^2}{4}} \qquad \text{(Equation 5-2)}$$

$$L = \frac{\sum(\ln \text{GMAV}) - S(\sum(\sqrt{P}))}{4} \qquad \text{(Equation 5-3)}$$

$$A = S\left(\sqrt{0.05}\right) + L \qquad \text{(Equation 5-4)}$$

$$\text{FAV} = e^A \qquad \text{(Equation 5-5)}$$

This FAV represents the 5% acute hazardous PFAS water concentration (HC5) that theoretically is protective of 95% of aquatic genera acutely exposed to that concentration. Dividing the FAV by 2 provides a more effective low effect level value (EPA 2015). The HC5 may alternatively be derived by performing a least squares regression of the four GMAV log values (if fewer than 59 values are available) on the percentile ranks.

5.1.2 Developing a Final Chronic Value

The PFAS-specific final chronic value (FCV) is the estimated chronic exposure level deemed protective of approximately 95% of the tested genera exposed to that concentration and will be used to develop the chronic ESV. The FCV will be calculated in one of two ways: (1) using the same approach employed to develop the FAV, or (2) by dividing the FAV by a final acute–chronic ratio (FACR).

5.1.2.1 FAV-based Approach

To develop a FCV using the FAV procedure (see Section 5.1.1), chronic toxicity values will be needed for species meeting eight data requirements (Table 5-1). If appropriate data are available, the FCV can be derived either by:

1. Calculating the geometric mean of effects concentrations from chronic tests; or
2. Analyzing the chronic data using regression analysis.

If available, values from the chronic toxicity tests may be used to develop a species-specific mean chronic value (SMCV) for each species in the dataset. The SMCV will be calculated as the geometric mean of the results of all acceptable lifecycle and partial lifecycle toxicity tests for the species. For fish species in the dataset, if no such lifecycle test results are available then the SMCV will be calculated as the geometric mean of all acceptable early life-stage tests for that species.

Next, a genus mean chronic value (GMCV) will be developed for each genus in the dataset. This GMCV will be calculated as the geometric mean of all SMCVs for each genus in the dataset. Next, all the GMCVs developed for the genera in the dataset will be ordered and assigned a rank, *R*, from lowest to highest. The FCV will then be developed using the four lowest-ranked GMCVs and applying Equations (5-1) through (5-5) but substituting SMCV for SMAV and GMCV for GMAV. Similar to the FAV/2, this FCV is the HC5 that represents the PFAS water concentration that theoretically is protective of 95% of aquatic species exposed to that concentration. Alternatively, the HC5 may be derived by performing a least squares regression of the four GMCV values (log values) on the percentile ranks.

5.1.2.2 Acute-to-Chronic Ratio Approach

If chronic values are not available to meet the eight data requirements for taxonomic families (Table 5-1), a FCV cannot be derived as described in Section 5.1.2.1. In such cases, an FCV will be developed using an acute-to-chronic ratio (ACR) derived using results from acute and chronic tests on the same species (Stephen et al. 1985; EPA 1995a). An ACR is derived by dividing a species-specific chronic toxicity value from an acceptable chronic test by an acute toxicity value from an acute test on the same species (Stephen et al. 1985; EPA 1995a). To be suitable for ACR derivation, the acute and chronic toxicity data must meet one of the following specific requirements:

- The acute and chronic toxicity tests were conducted as part of the same study, by the same laboratory, using the same species and dilution water;
- The acute toxicity test was conducted in a separate study, but by the same laboratory, using the same species and dilution water; or
- The acute toxicity test was conducted in a separate study by a different laboratory, but using the same species and same dilution water.

If necessary, acute and chronic data from the same species, regardless of test conditions, may be used. If no such acute toxicity test data are available, ACR development will not be possible.

If suitable data are available, an ACR will be calculated for each species as:

$$SMACR = \frac{SMAV}{SMCV} \quad \text{(Equation 5-6)}$$

where:

SMACR = Species Mean Acute-Chronic Ratio;

SMAV = Species Mean Acute Value; and

SMCV = Species Mean Chronic Value.

The SMAV is the geometric mean of the results of all acceptable acute tests and the SMCV is the geometric mean of the results of all acceptable chronic tests. Next, a species mean acute-chronic ratio (SMACR) for a given species will be calculated as the geometric mean of all the SACRs for that species. If the minimum ACR data requirements described earlier are not met with freshwater data alone, saltwater data may be used along with the freshwater data to provide a sufficient dataset (Stephen et al. 1985; EPA 1995a).

The 1995 GLI guidance identifies derivation of a final ACR (FACR) in one of the three following ways:

1. If the SMACR appears to increase or decrease as the SMAVs increase, the FACR will be calculated as the geometric mean of the SMACRs for species in the dataset whose SMAVs are close to the FAV;
2. If no major trend is apparent and the SMACRs for all species in the dataset are within a factor of 10, the FACR will be calculated as the geometric mean of all the SMACRs; or
3. If the most appropriate SMACRs are less than 2.0, and especially if less than 1.0, the FACR will be assumed to be 2.[2]

If the available PFAS-specific SMACRs do not allow use of any of these three approaches, it will not be possible to derive a useable FACR, and neither a PFAS-specific FCV nor a Tier I ESV for chronic exposure can be calculated.

Sufficient data were available for Tier I FACR derivation for only PFOA and PFAS. Following discussions with the EPA Interagency Team, the PFOA FACR was the highest SMACR calculated from the available PFOA data. For PFOS, the FACR was calculated as the 90th percentile value of the SMACRs.

[2] In such cases, acclimation is assumed to have occurred during the chronic test, and thus continuous exposure and acclimation cannot be assured to provide adequate protection in field situations (EPA 1995a).

For PFOA and PFOS, the FCV can be calculated as:

$$FCV = \frac{FAV}{FACR} \quad \text{(Equation 5-7)}$$

where:

FCV = final chronic value;
FAV = final acute value; and
FACR = final acute–chronic ratio.

5.1.3 Final Aquatic Plant Value

Pending data availability, the derivation of a Tier I PFAS ESV includes consideration of aquatic plant toxicity data to derive a final plant value (FPV). The FPV is the lowest plant toxicity value for an important aquatic plant species in an acceptable toxicity test for which a PFAS concentration was measured and the adverse effect was biologically important. The FPV will be based on 96-hour tests conducted with algae, or chronic tests conducted with an aquatic vascular plant (Stephen et al. 1985; EPA 1995a). The FPV will then be lowest result among the acute and chronic tests.

5.1.4 Tier I PFAS ESV Derivation

Depending on data availability, two Tier I PFAS ESVs will be developed:

- Maximum ESV (acute exposure ESV), and
- Continuous ESV (chronic exposure ESV).

For a specific PFAS, the acute exposure ESV will be calculated as one-half the PFAS-specific FAV and represents the highest concentration of the specific PFAS in the water column to which an aquatic community can be briefly exposed without resulting in an unacceptable effect.

The chronic exposure ESV will be the lowest of the FCV or the FPV (if available) and represents the highest concentration of the specific PFAS in the water column to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

5.2 Development of a Tier II ESV

If insufficient data are available to develop Tier I ESVs, a Tier II ESV will be developed following the methodology presented in the Great Lakes Water Quality Initiative guidance (EPA 1995a). The Tier II methodology uses available aquatic toxicity test data to calculate secondary acute and chronic values, and secondary acute-chronic ratios. These values in turn are used develop secondary maximum and continuous water concentrations for the protection of aquatic biota.

5.2.1 Derivation of Secondary Acute Values

If species-specific toxicity test data are available meeting only some of the eight data requirements for taxonomic families used to derive a Tier I FAV (Table 5-1), a secondary acute value (SAV) will be calculated as follows. A SMAV will be calculated for each species with available toxicity test data. For a freshwater ESV, the dataset at a minimum must include data for one of the following three genera in the family Daphnidae: *Ceriodaphnia*, *Daphnia*, or *Simocephalus*. For marine ESVs, the dataset should include data from one of the following families: Mysidae or Penaeidae. Next, a GMAV will be calculated as the geometric mean of the SMAVs for all species in that genus. The resultant GMAVs will then be ranked from lowest to highest, and a SAV will be calculated by dividing the lowest GMAV by a secondary acute factor (SAF) (Table 5-2) from the GLI methodology (EPA 1995a):

$$SAV = \frac{GMAV_L}{SAF} \quad \text{(Equation 5-8)}$$

where:

SAV = secondary acute value;
$GMAV_L$ = lowest GMAV from the available toxicity test data; and
SAF = secondary acute factor, based on number of required Tier I taxa

Table 5-2 Secondary Acute Factors (EPA 1995a)

Number of Tier I Taxonomic Families in the Tier II Dataset	Adjustment Factor
1	21.9
2	13.0
3	8.0
4	7.0
5	6.1
6	5.2
7	4.3

The SAF corresponds to the number of the Tier I taxonomic families in the dataset (Table 5-1). For example, if acute toxicity test data are available for species from only three of the eight Tier I families, the SAV would be calculated as the lowest GMAV divided by an SAF of 8.0.

5.2.2 Derivation of Secondary Final Acute-Chronic Ratios

If three or more suitable experimentally determined ACRs (EPA 1995a) are available, a FACR can be developed using the Tier I procedure described in Section 5.1.2.2. However, if fewer than three ACRs are available, it will not be possible to develop an FACR following the Tier I

methodology. In such cases, the GLI guidance (EPA 1995a) uses the following approach to derive a secondary FACR. If fewer than three ACRs are available, one or two ACRs—each with a default value of 18—will be used so that there are three ACRs (Table 5-3). The secondary FACR (SFACR) will then be calculated as the geometric mean of the three ACRs. If no experimentally determined ACRs are available, the SFACR will be assigned a value of 18 (EPA 1995a).

Table 5-3 Hypothetical Example of Employing Assumed ACR Values for Use in Developing a SFACR Following EPA Methodology Guidance (EPA 1995a)

Case 1: Three ACRs Available	Case 2: Two ACRs Available	Case 1: One ACR Available
4.5	4.5	4.5
6.9	6.9	18
1.4	18	18
FACR[a] = 3.5	SFACR = 8.2	SFACR = 11.3

[a] FACR and SFACR are calculated as the geometric mean of the three ACRs.

Because the default value of 18 was considerably below the ACRs that were derived with the available data for PFOA and PFOS, this default value was not considered appropriate for use in developing SFACRs. For the perfluorocarboxylic acids other than PFOA, the 90th percentile of the individual PFOA ACRs (instead of 18) was used as the default SACR. For the perfluorosulfonic acids other than PFOS, the 90th percentile of the individual PFOS ACRs was used as the default SFACR.

5.2.3 Secondary Chronic Value

Once the SAV and SACR (or FACR) values are developed for a specific PFAS, the PFAS-specific secondary chronic value (SCV) will be calculated using one of the following:

$$SCV = \frac{FAV}{SACR} \quad \text{(Equation 5-9)}$$

$$SCV = \frac{SAV}{FACR} \quad \text{(Equation 5-10)}$$

$$SCV = \frac{SAV}{SACR} \quad \text{(Equation 5-11)}$$

where:

SCV = secondary chronic value;
FAV = final acute value (from Tier 1 evaluation);
SACR = secondary acute–chronic ratio;
SAV = secondary acute value; and
FACR = final acute–chronic ratio.

5.2.4 Tier II ESV Derivation

Under the Tier II ESV methodology, two PFAS-specific ESVs will be derived:

- Secondary acute exposure ESV, and
- Secondary chronic exposure ESV.

Similar to the Tier I ESV values, the secondary acute exposure ESV will be calculated as one-half the PFAS-specific SAV (EPA 1995a).

$$\text{secondary acute exposure ESV} = \frac{SAV}{2} \qquad \text{(Equation 5-12)}$$

This value represents the highest concentration of the specific PFAS in the water column to which an aquatic community can be briefly exposed without resulting in an unacceptable effect.

The Tier II secondary chronic exposure ESV will be the lowest of the SCV or, if available, a FPV as determined in the Tier I methodology (see Section 5.1.3). The secondary chronic exposure ESV value represents the highest concentration of a specific PFAS in the water column to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

5.3 References

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6 DERIVATION OF AQUATIC ESVS FOR WILDLIFE

As with the development of PFAS ESVs for the protection of aquatic biota (Section 5), a two-tiered methodology will also be used to develop aquatic screening levels for the protection of wildlife. These ESVs represent the PFAS concentration at or below which exposure to birds or mammals is not expected to result in unacceptable adverse impacts to growth, reproduction, or survival. This methodology is based in large part on the 1995 GLI Tier I and Tier II methods for deriving water quality criteria to protect wildlife (EPA 1995b, c). The aquatic ESVs for wildlife will support screening ecological risk assessments of surface waters.

6.1 Representative Species for ESV Development

Piscivorous species are the focus of concern for development of the wildlife aquatic PFAS ESVs. Based on the analysis of known or estimated exposure factors for avian and mammalian wildlife species presented in the GLI guidance and technical support documents for developing wildlife criteria (EPA 1995b, c), three avian species and two mammalian species have been selected as representative species for use in developing the wildlife aquatic PFAS ESV (Table 6-1).

Table 6-1 Representative Species for Use in Developing Tier I and Tier II PFAS ESVs

Avian Species	Mammalian Species
Belted Kingfisher	River Otter
Herring Gull	Mink
Osprey	

As discussed in the GLI guidance (EPA 1995b, c), these species are considered representative of avian and mammalian species that are likely to have the highest potential for PFAS exposure through the aquatic food web. Each of the avian species may be found throughout the United States, with the belted kingfisher largely restricted to foraging in freshwater habitats, while the herring gull and osprey may forage in freshwater and also marine coastal habitats. Besides these piscivorous species, other non-piscivorous species (such as shorebirds and some waterfowl) may be exposed through the ingestion of contaminated media while foraging or through the food chain while consuming aquatic and semi-aquatic biota. The two mammalian species also forage in freshwater and marine coastal habitats. Other wildlife species may be selected, following review of the available toxicity data and discussions with the Interagency Team.

6.2 Derivation of Avian and Mammalian Wildlife Values

Development of the wildlife aquatic ESVs first requires first deriving a wildlife value (WV) for each of the representative bird and mammalian species using the following equation:

$$\mathrm{WV_{PFAS}} = \frac{\left(\frac{\mathrm{TD}}{UF_A \times UF_S \times UF_L}\right) \times W_t}{W + \sum(F_{TLi} \times BAF_{TLi}^{Wt})} \qquad \text{(Equation 6-1)}$$

Where:

WV_{PFAS}	=	Wildlife value (mg PFAS/L);
TD	=	Test dose (mg PFAS/kg bodyweight/day) for test species that represents a NOAEL or LOAEL dose;
UF_A	=	Uncertainty factor (UF) for extrapolating toxicity data across species (unitless);
UF_S	=	UF for extrapolating from subchronic to chronic exposures (unitless);
UF_L	=	UF for LOAEL to NOAEL extrapolations (unitless);
W_t	=	Average weight (kg) for the representative species;
W	=	Average daily water consumption (L/day) by the representative species;
F_{TLi}	=	Average daily food consumption rate (kg/day) from trophic level *i* by the representative species; and
BAF_{LTi}^{WL}	=	Bioaccumulation factor for wildlife food in trophic level *i* (L/kg).

The final avian WV will be the geometric mean of the WVs of the representative avian species, and the final mammalian WV will be the geometric mean of the WVs for the representative mammalian species[3] (Table 6-1).

6.2.1 Test Dose Selection and Conversion

For a representative species, multiple test doses may be available from various studies. If multiple values are available, selection of which test dose to use in WV derivation will be based on the following considerations (from EPA 1995b):

1. If, based on different toxicity endpoints, more than one test dose is available within a taxonomic class (e.g., for multiple avian species), the dose from the most sensitive species and which best reflects potential impacts to wildlife populations due to changes in mortality, growth, or reproduction will be selected.
2. If more than one test dose is available within a taxonomic class and all are based on the same endpoint, the dose will be selected from the most sensitive species.
3. If multiple test doses are available from various studies for a given species and are based on the same toxicity endpoint, the test dose used for that species will be the geometric mean of those test doses.

Whatever test dose is selected, it must be in appropriate units: milligram of PFAS per kilogram of bodyweight per day (mg/kg/day, wet weight). If the dose is in other units, the following procedures will be used to convert the test dose to the units needed to calculate a WV:

[3] The geometric mean of two numbers is the square root of the product of the two numbers

- If the test dose is given in milligrams of PFAS per liter of water consumed (mg/L), the dose will be multiplied by the daily average volume of water consumed by the test animals (L/day) and divided by the average weight (kg) of the test animals; or
- If the test dose is given in milligrams of PFAS per kilogram of food consumed (mg/kg), the dose will be multiplied by the average amount of food consumed daily (kg/day) and divided by the average weight of the test animals in kilograms (kg) (EPA 1995b).

For these conversions, the drinking and feeding rates, as well as bodyweight, will be those reported in the associated study. If the study does not provide the exposure information for the test species, this information will be derived using the exposure estimation methods presented in Chapter 4 of the *Wildlife Exposure Factors Handbook* (EPA, 1993) together with the methods and recommendations presented in the GLI *Technical Support Document for Wildlife Criteria* (EPA 1995c).

6.2.2 Uncertainty Factors

6.2.2.1 LOAEL to NOAEL Extrapolations Using Uncertainty Factors (UF_L)

In calculating a species-specific WV (Equation 6-1), the preferred test dose is a NOAEL dose for the target species and based on a chronic toxicity test. If the test dose is available only as a LOAEL, the NOAEL will be estimated by dividing the LOAEL by an uncertainty factor[4] (UF_L in Equation 6-1) ranging from 1 and 10, depending on the dose-response curve and any other available data. Selection of an appropriate UF_L will follow the procedures and recommendations presented in GLI technical support documents for wildlife and human health criteria development (EPA 1995c, e), as well as discussion with and input from the Interagency Team.

6.2.2.2 Sub-chronic to Chronic Extrapolations (UF_S)

When only sub-chronic data are available, the test dose will be derived by extrapolating from sub-chronic to chronic levels. This will be done by dividing the sub-chronic value by an appropriate UF (UF_S in Equation 6-1) ranging from 1 to 10. Selection of an appropriate UF_S will follow the guidance presented in GLI wildlife criteria technical support document (EPA 1995c), as well as discussion with and input from the Interagency Team.

6.2.2.3 Interspecies Extrapolations (UF_A)

If a test dose is not available for the target representative species (Table 6-1), available dose values from other species (within the same class) will be extrapolated to the target representative species. For this extrapolation (which will follow a taxonomic hierarchy from genus to higher-level taxonomic groupings), the non-target-species test dose will be divided by an UF (UF_A in Equation 6-1) ranging from 1 to 100 depending on the species. Selection of the appropriate UF_A

[4] Uncertainty factors referred to here and in Equation 6-1 account for uncertainty when applying a dose response in one species to another species, for converting from sub-chronic to chronic exposures, and for estimating a NOAEL from a LOAEL. In the latter two cases, the uncertainty factors incorporate a factor that accounts for a change in magnitude in the converted values.

will follow the guidance presented in the GLI wildlife criteria technical support document (EPA 1995c), as well as considerations of discussions with, and input from, the Interagency Team. The application of a UF_A will only apply to extrapolation across species within a taxonomic class, and not for interclass extrapolations.

6.2.3 Bioaccumulation Factors

In the GLI methodology (EPA 1995c), the calculation of a WV may incorporate a BAF[5] for wildlife food from different trophic levels (see Equation 6-1), with the BAF obtained from published studies (of acceptable quality [see Section 2]). The GLI guidance (EPA 1995b) discusses deriving BAFs when evaluating food chain uptake via the consumption of piscivorous birds by other birds (e.g., herring gull by eagles). The GLI guidance also calls for the BAF to be derived by multiplying the trophic level 3 BAF for fish by a biomagnification factor to account for the biomagnification from fish to the consumed birds. Although this is appropriate for many organic compounds, it may be less appropriate for PFAS compounds.

In general, the more lipophilic a compound (as measured by its octanol-water partition coefficient, K_{OW}), the higher the tendency for that compound to bioaccumulate. However, PFAS molecules are partly lipophilic and partly hydrophilic, and thus the K_{OW} becomes less of an indicator of possible bioaccumulation. Rather, the length of each PFASs fluorinated chain length appears to be a better indicator of bioconcentration and bioaccumulation potential. For example, perfluorinated sulfonates appear to be more bioaccumulative than perfluorinated carboxylates of the same fluorinated carbon number, while perfluorinated carboxylates with seven or fewer fluorinated carbons appear to have low bioaccumulation and biomagnification potential in food webs (Conder et al. 2008).

A determination will be made of the availability of PFS-specific BAFs, and if available the BAFs will be used. The trophic level to which a PFAS-specific BAF will be applied will be the same as the trophic level of the organisms used in the determination of the BAF. If more than one BAF is available for a given species and trophic level, a species mean BAF will be calculated as the geometric mean of the BAFs. If a BAF is available for either trophic level 3 or 4, but not both, a baseline BAF for the other trophic level will be calculated following the procedures described in GLI Methodology for Deriving Bioaccumulation Factors (EPA 1995d). Acceptability of reported field-measured BAFs or reported derived BAFs will be evaluated using the criteria and procedures identified in the GLI BAF methodology (EPA 1995d).

6.3 Derivation of the Tier I and II Aquatic ESVs for the Protection of Wildlife

Under the Tier I methodology two WVs are calculated (using Equation 6-1), one for birds and one for mammals. The lowest of these is selected as the wildlife PFAS aquatic ESV:

Tier I Aquatic ESV for Wildlife = lowest of the Avian and Mammalian WVs

[5] The BAF is the ratio (in L/kg) of a substance's concentration in tissue of an aquatic organism to its concentration in the ambient water, in situations where both the organism and its food are exposed to the ambient water concentrations, and the ratio does not change substantially over time.

If insufficient data are available to develop both avian and mammalian WVs, then a Tier II ESV will be developed as follows. A single, class-specific (Aves or Mammalia, whichever has the appropriate data) WV is developed using the same methodology as described for Tier I (using Equation 6-1). This class-specific WV then becomes the Tier II ESV:

$$\text{Tier II Aquatic ESV for Wildlife} = \text{Class-specific WV}$$

This Tier II ESV will be applicable only to biota from the specific class for which it was developed.

6.4 References

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APPENDIX B: TERRESTRIAL PLANTS AND INVERTEBRATES

B.1 TERRESTRIAL PLANTS

Table B.1-1 Ecological Screening Value for Perfluorooctanoic Acid (PFOA) for Terrestrial Plants in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	EC20 (mg/kg)	EC10 (mg/kg)	ESV Calc (mg/kg)
Gonzalez-Naranjo, V., and K. Boltes, 2014	176911	*Sorghum bicolor*	Broomcorn	Growth	19.21		19.21
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		177	177
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		98	98
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		48	48
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		103	103
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		96	96
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		120	120
Zhou, L., M. Xia, L. Wang, and H. Mao, 2016	175702	*Triticum aestivum*	Bread wheat	Growth		83.8	83.8
				Ecological Screening Value, ESV (mg/kg)			**79.47**

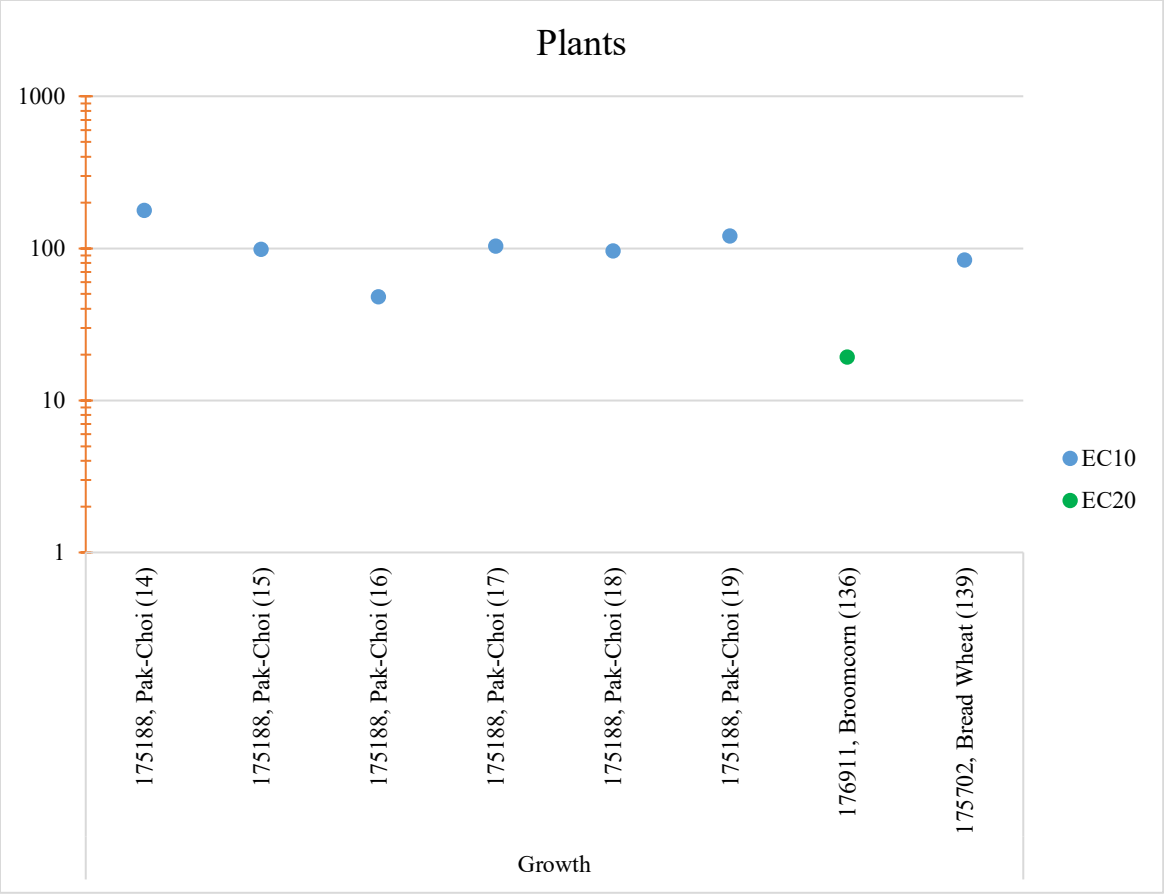

Figure B.1-1 PFOA Toxicity Values for Direct Exposure of Plants in Soil (mg/kg)

Table B.1-2 Ecological Screening Value for Perfluorooctanesulfonic Acid (PFOS) for Terrestrial Plants in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	EC25 (mg/kg)	EC10 (mg/kg)	Value for Calc
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Medicago sativa*	Alfalfa	Growth	53.3		53.3
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Linum usitatissimum*	Flax	Growth	81.6		81.6
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Allium cepa*	Common onion	Growth	12.9		12.9
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Lactuca sativa*	Lettuce	Growth	6.79		6.79
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Lolium perenne*	Perennial ryegrass	Growth	7.51		7.51
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Glycine max*	Soybean	Growth	160		160
Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2003	175361	*Solanum lycopersicum* var. *lycopersicum*	Tomato	Growth	11.7		11.7
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		115	115
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		58	58
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		40	40
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		72	72
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		83	83
Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan, 2011	175188	*Brassica chinensis*	Pak-choi	Growth		90	90
						ESV (mg/kg)	**40.42**

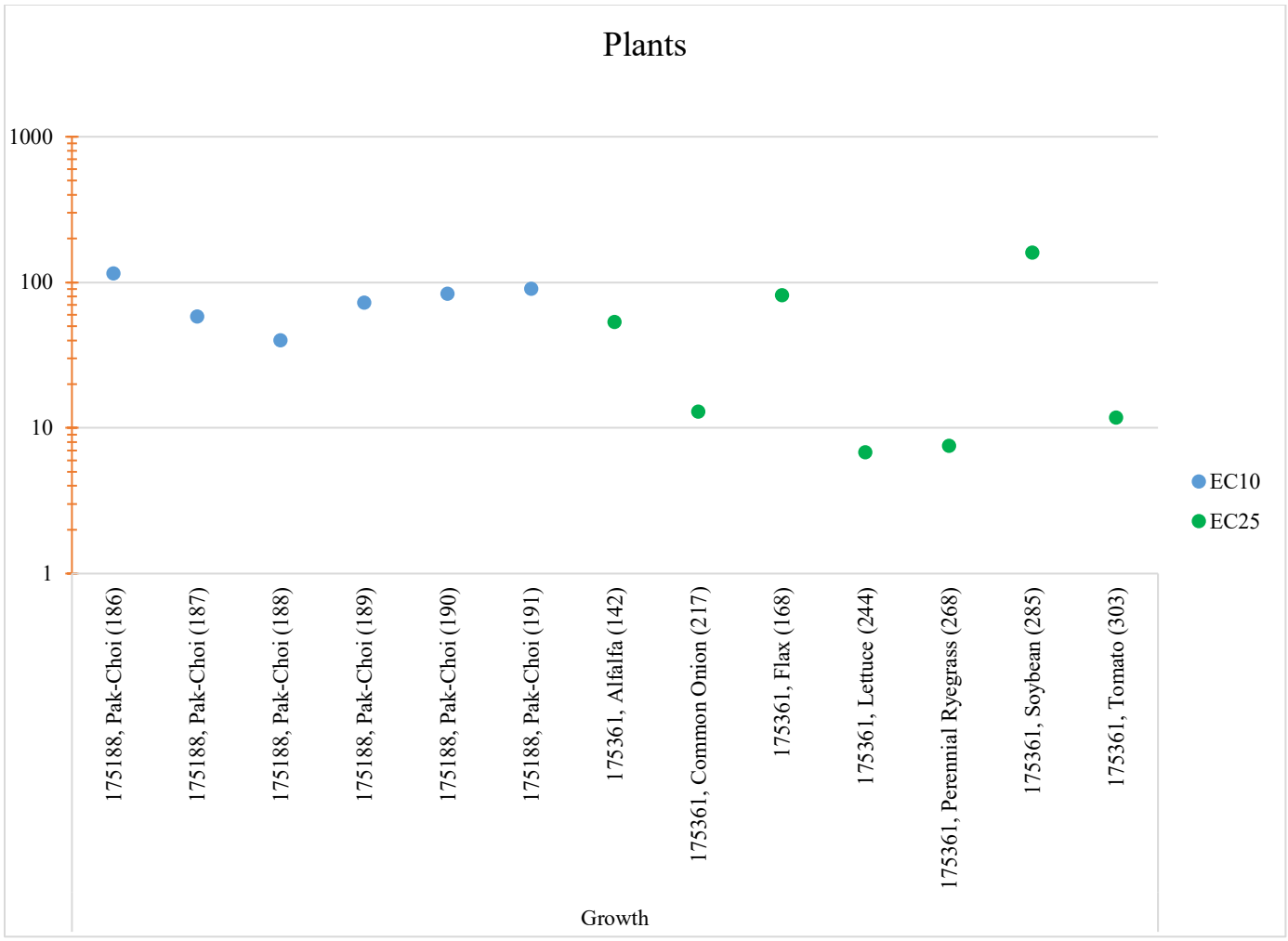

Figure B.1-2 PFOS Toxicity Values for Direct Exposure of Plants in Soil (mg/kg)

B.2 SOIL INVERTEBRATES

Table B.2-1 Ecological Screening Value for PFOA for Terrestrial Invertebrates in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	LOAEL	NOAEL	MATC[a]	ESV calc
Zareitalabad, P., J. Siemens, F. Wichern, W. Amelung, and R.G. Joergensen, 2013	175666	*Aporrectodea caliginosa*	Worm	Growth	100			
Zareitalabad, P., J. Siemens, F. Wichern, W. Amelung, and R.G. Joergensen, 2013	175666	*Aporrectodea caliginosa*	Worm	Growth		1	10	10
Zheng, X.Q., Y.J. Shi, Y.L. Lu, and X.B. Xu, 2016	176944	*Eisenia fetida*	Earthworm	Growth	50			50
							ESV (mg/kg)	22.36

[a] Maximum acceptable threshold concentration (MATC) was calculated here as the geometric mean of the associated lowest observed adverse effect level (LOAEL) and no observed adverse effect level (NOAEL) values in the study.

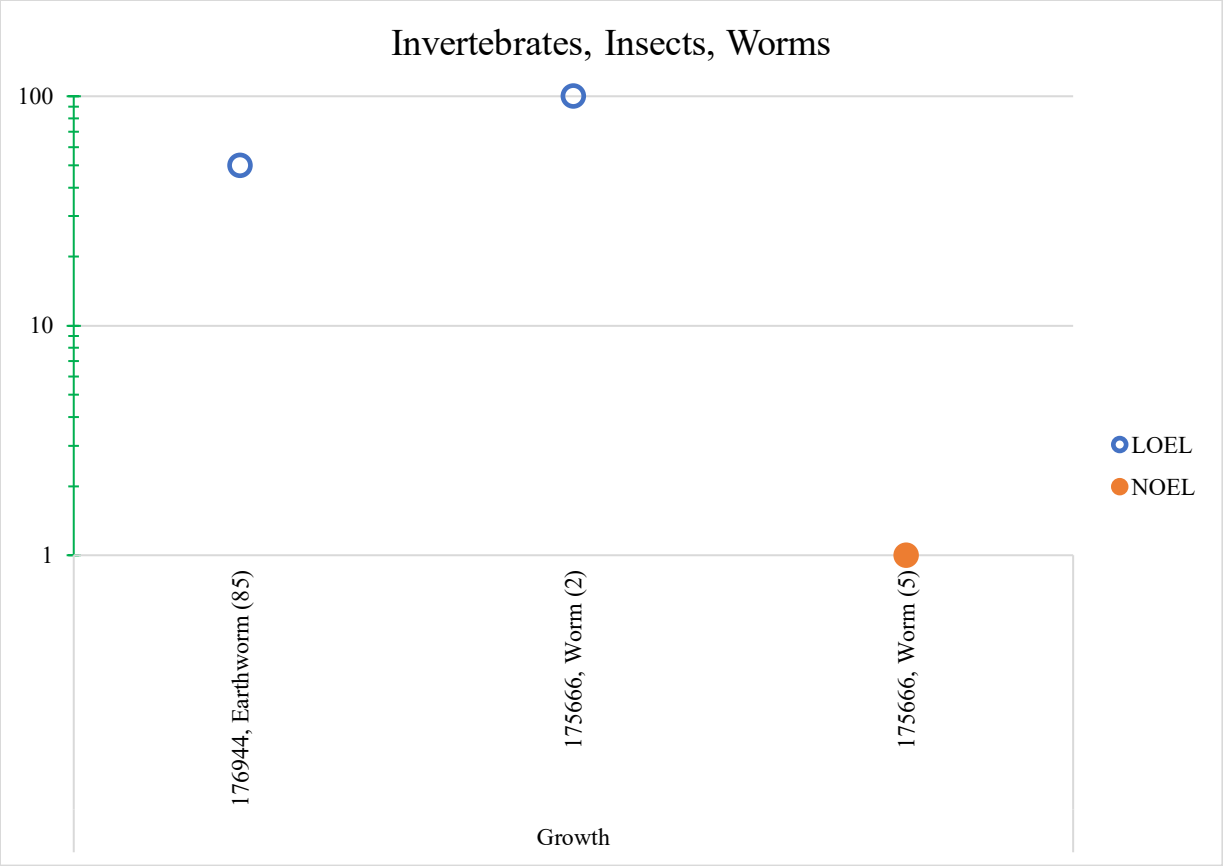

Figure B.2-1 PFOA Toxicity Values for Direct Exposure of Invertebrates in Soil (mg/kg)

Table B.2-2 Ecological Screening Value for Perfluorononanoic Acid (PFNA) for Terrestrial Invertebrates in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	LOAEL	NOAEL	MATC[a]
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Growth	100		
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Growth		1	10
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Mortality	100		
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Mortality		1	10
						ESV (mg/kg)	10

[a] MATC was calculated here as the geometric mean of associated LOAEL and NOAEL values in the study.

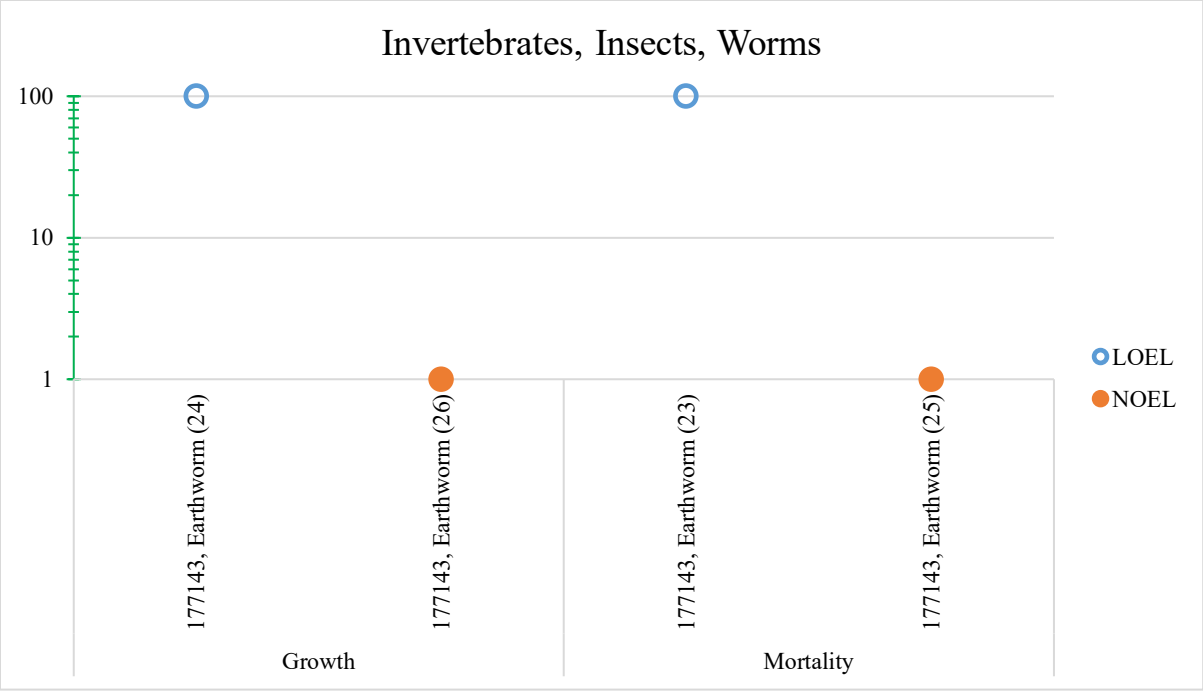

Figure B.2-2 PFNA Toxicity Values for Direct Exposure of Invertebrates in Soil (mg/kg)

Table B.2-3 Ecological Screening Value for Perfluorobutanesulfonic Acid (PFBS) for Terrestrial Invertebrates in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	NOAAEL
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Growth	100
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Mortality	100
				ESV (mg/kg)	100

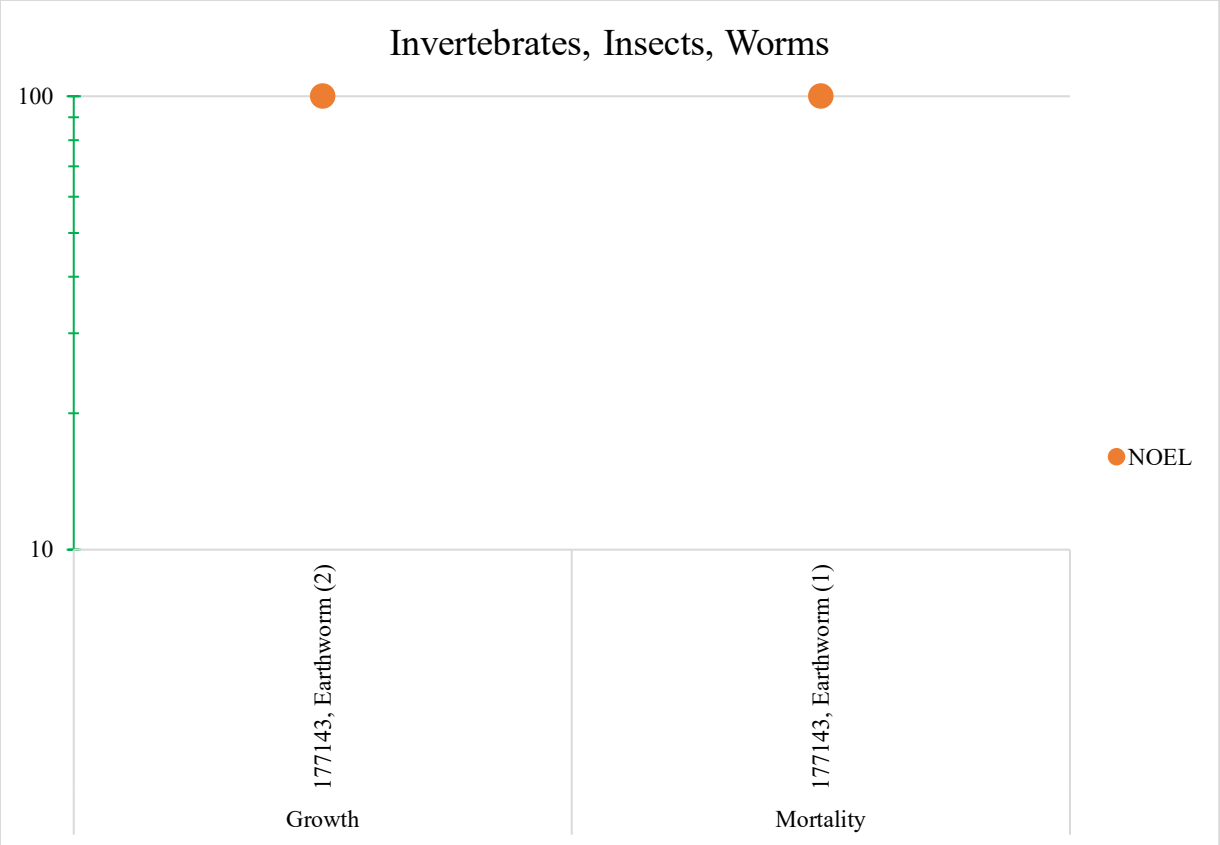

Figure B.2-3 PFBS Toxicity Values for Direct Exposure of Invertebrates in Soil (mg/kg)

Table B.2-4 Ecological Screening Value for Perfluorohexanesulfonic Acid (PFHxS) for Terrestrial Invertebrates in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	NOAEL	LOAEL	MATC[a]
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Growth	100		
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Mortality		100	
Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson, 2018	177143	*Eisenia fetida*	Earthworm	Mortality	1		10
						ESV (mg/kg)	10

[a] MATC was calculated here as the geometric mean of the associated LOAEL and NOAEL values in the study.

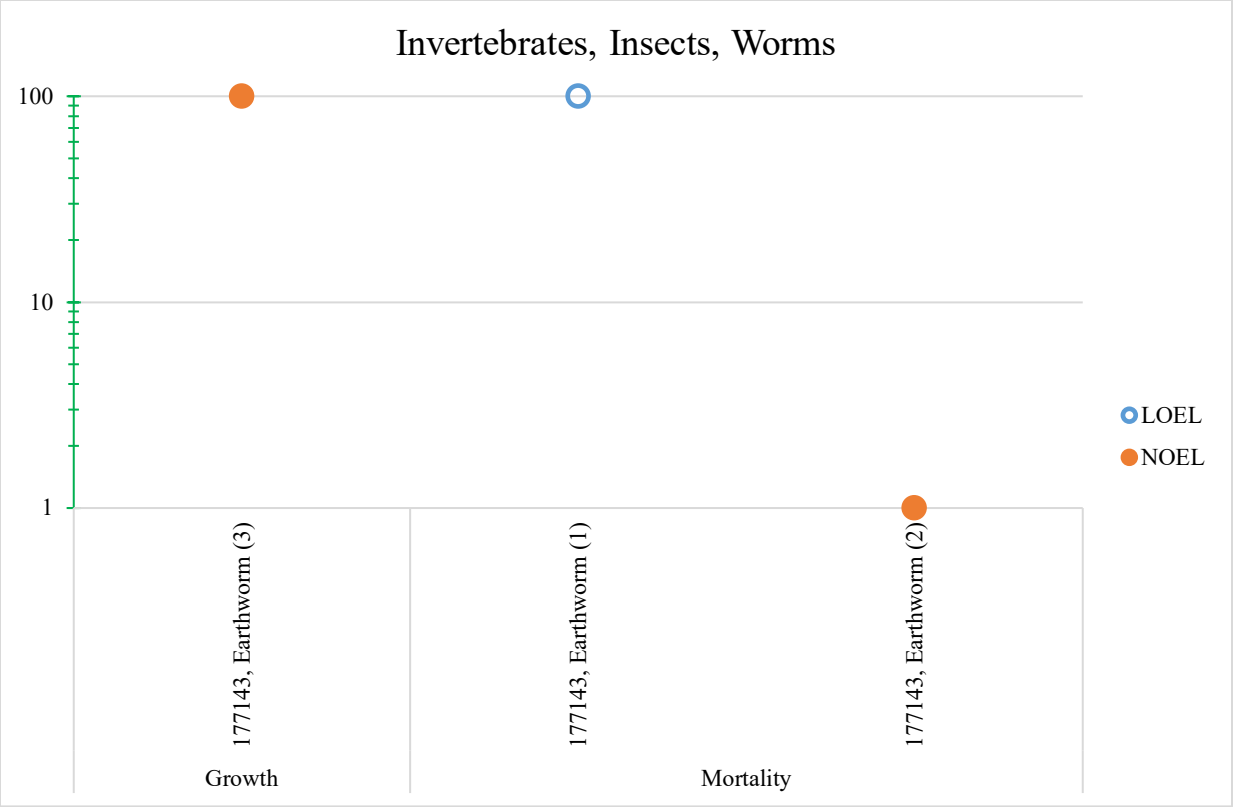

Figure B.2-4 PFHxS Toxicity Values for Direct Exposure of Invertebrates in Soil (mg/kg)

Table B.2-5 Ecological Screening Value for PFOS for Terrestrial Invertebrates in Soil (mg/kg)

Author, Year	ECOTOX Reference Number	Species Scientific Name	Species Common Name	Effect	IC25	LOEC	NOEC	LOAEL	NOAEL	MATC[a]	Value for Calc
Princz, J., M. Jatar, H. Lemieux, and R. Scroggins, 2018	178027	*Oppia nitens*	Mite	Repro-duction	13						13
Princz, J., M. Jatar, H. Lemieux, and R. Scroggins, 2018	178027	*Oppia nitens*	Mite	Repro-duction	33						33
Princz, J., M. Jatar, H. Lemieux, and R. Scroggins, 2018	178027	*Folsomia candida*	Springtail	Repro-duction	74						74
Princz, J., M. Jatar, H. Lemieux, and R. Scroggins, 2018	178027	*Folsomia candida*	Springtail	Repro-duction	185						185
Sindermann, A.B., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2002	177116	*Eisenia fetida*	Earthwor m	Growth		141					
Sindermann, A.B., J.R. Porch, H.O. Krueger, and R.L. Van Hoven, 2002	177116	*Eisenia fetida*	Earthwor m	Growth			77			104.2	104.2
Xu, D., C. Li, Y. Wen, and W. Liu, 2013	166647	*Eisenia fetida*	Earthwor m	Growth				120			
Xu, D., C. Li, Y. Wen, and W. Liu, 2013	166647	*Eisenia fetida*	Earthwor m	Growth					80	98.0	98.0
Zareitalabad, P., J. Siemens, F. Wichern, W. Amelung, and R.G. Joergensen, 2013	175666	*Aporrectodea caliginosa*	Worm	Growth				100			
Zareitalabad, P., J. Siemens, F. Wichern, W. Amelung, and R.G. Joergensen, 2013	175666	*Aporrectodea caliginosa*	Worm	Growth					1	10.0	10.0
										ESV (mg/kg)	**48.14**

[a] MATC was calculated here as the geometric mean of the associated LOAEL and NOAEL values in the study.

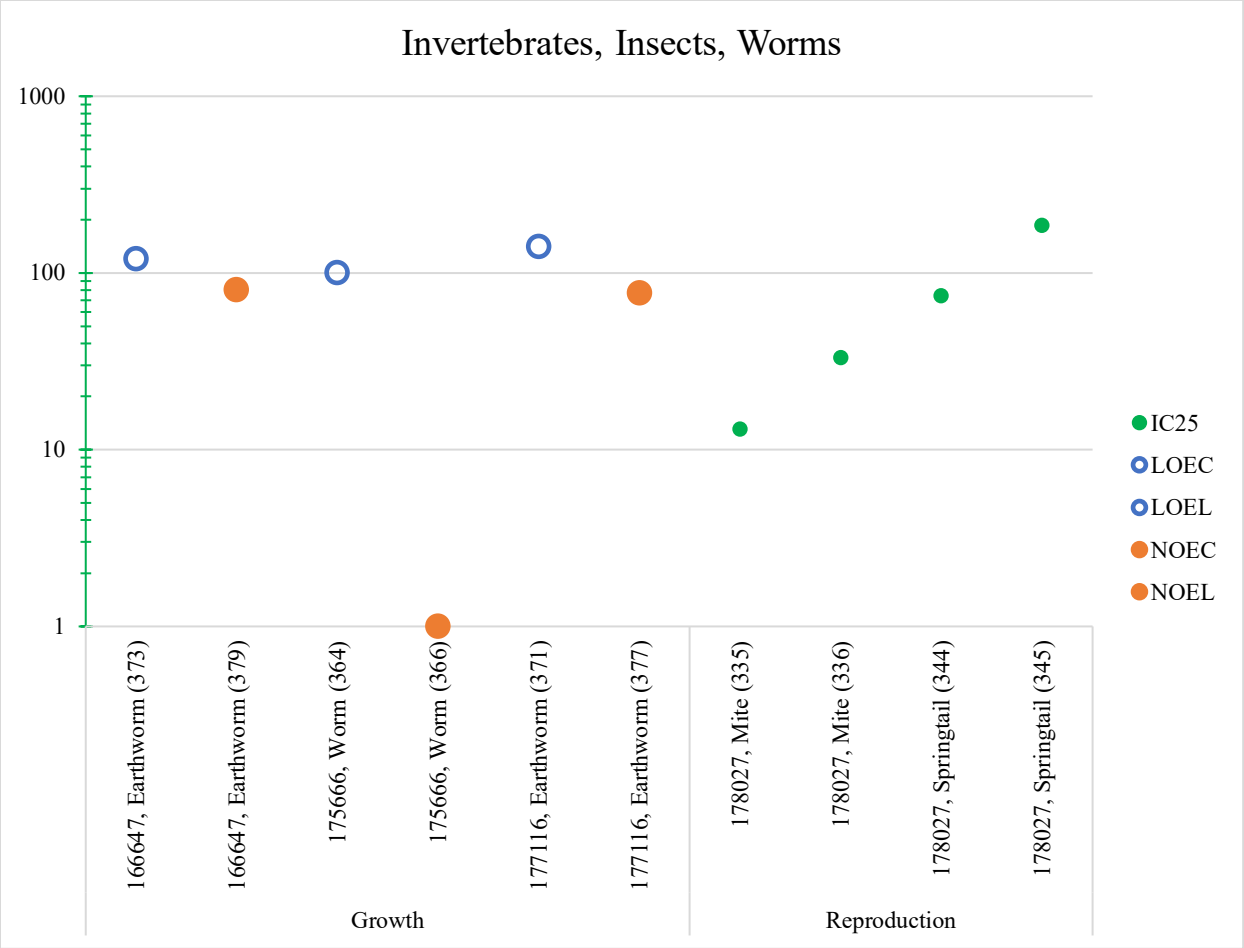

Figure B.2-5 PFOS Toxicity Values for Direct Exposure of Invertebrates in Soil (mg/kg)

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APPENDIX C: TERRESTRIAL BIRDS AND MAMMALS

C.1 EXPOSURE FACTORS FOR TERRESTRIAL WILDLIFE

Exposure factors used as inputs for modeling exposure of representative mammal and bird species to PFAS compounds is presented in Table C-1. The values were determined based on U.S. Environmental Protection Agency (EPA) guidance for developing soil-based ecological screening values (EPA 2005) and the methodology identified in Appendix A.

Table C-1 Input Exposure Factors for Estimating ESVs for Representative Species of Terrestrial Mammals and Birds

Receptor Group (Surrogate Species)[a]	Assumed Diet	Food Ingestion Rate[b] (FIR, kg dw/kg bw day)	Soil Ingestion[c] (P_s)
Mammalian Herbivore (Meadow Vole)	100% foliage	0.0875	0.032
Mammalian Ground Invertivore[d] (Short-tailed shrew)	100% earthworms	0.209	0.030
Mammalian Carnivore (Long-tailed weasel)	100% small mammals	0.130	0.043
Avian Granivore (Mourning dove)	100% seeds	0.190	0.139
Avian Ground Invertivore[d] (American woodcock)	100% earthworms	0.214	0.164
Avian Carnivore (Red-tailed hawk)	100% small mammals that consume 100% earthworms	0.0353	0.057

[a] Source: EPA (2005).
[b] High-end point estimate based on measured data (see EPA 2005, Attachment 4-1 for derivation); dw = dry weight; bw = receptor bodyweight.
[c] Soil ingestion as proportion of diet (See EPA 2005 Attachment 4-1 for derivation).
[d] Uptake for invertivores will be estimated in the models by assuming earthworm prey.

C.1.1 REFERENCES

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C.2 BIOACCUMULATION FACTORS (BAFs) FOR ESTIMATING EXPOSURE TO AQUATIC WILDLIFE

Bioaccumulation factors used to estimate concentrations of per- and polyfluorinated alky substances (PFAS) in prey items based upon exposure to soil containing PFAS and used as inputs for modeling exposure of representative mammal and bird species to PFAS are presented in Table C-2.

Table C-2 Bioaccumulation Factors Used for Estimating Food Chain Exposure of Terrestrial Wildlife to PFAS

PFAS	Soil to Invertebrates	Soil to Plants	Soil to Small Mammals
Carboxylic Acids			
PFBA	7[a]	8[a]	NA[c]
PFHxA	1.9[a]	2.2[a]	NA[c]
PFOA	2.15[b]	0.11[a]	NA[c]
PFNA	4.08[b]	1.1[a]	NA[c]
PFDA	5.27[b]	0.7[a]	NA[c]
Sulfonic Acids			
PFBS	3[a]	3.6[a]	NA[c]
PFHxS	23.6[b]	1.5[a]	NA[c]
PFOS	18.0[b]	0.66[a]	11[a]

[a] Based upon estimates provided in Divine et al. (2020).
[b] Rich et al. (2015). Estimate based on 28-day exposure of earthworms to various soil types.
[c] No value identified. A default value of 1.0 was used as an estimate.

C.2.1 REFERENCES

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C.3 TOXICITY REFERENCE VALUES FOR TERRESTRIAL MAMMALS AND BIRDS

The toxicity reference values (TRVs; mg PFAS/kg organism bodyweight per day) that were used as doses to calculate ecological screening values (ESVs) for terrestrial wildlife exposed to contaminated soils were derived based upon a review of existing literature as described in Appendix A. Appendix F presents an overview of the studies reviewed for the development of PFAS ESVs, including evaluations of acceptance and rejection criteria. Table C-3 presents the final TRVs that were derived for representative terrestrial mammals and birds. As described in Appendix A, an uncertainty factor of 10 was applied to the TRVs when modeling the ESVs for terrestrial wildlife (mammals and birds) to account for interspecific sensitivity differences between test organisms and the species selected as surrogate receptors.

Table C-3 TRVs for Terrestrial Mammals and Birds[a]

Compound	Mammalian Herbivore (Meadow Vole)	Mammalian Ground Invertivore (Short-tailed Shrew)	Mammalian Carnivore (Long-tailed Weasel)	Avian Granivore (Mourning Dove)	Avian Ground Invertivore (American Woodcock)	Avian Carnivore (Red-tailed Hawk)
Carboxylic Acids						
PFBA	4.38[b]	4.38[b]	4.38[b]	NA[c]	NA[c]	NA[c]
PFHxA	2.50[d]	2.50[d]	2.50[d]	NA[c]	NA[c]	NA[c]
PFOA	1.75[e]	1.75[e]	1.75[e]	NA[c]	NA[c]	NA[c]
PFNA	0.021[f]	0.021[f]	0.021[f]	NA[c]	NA[c]	NA[c]
PFDA	0.075[g]	0.075[g]	0.075[g]	NA[c]	NA[c]	NA[c]
Sulfonic Acids						
PFBS	5.3[h]	5.3[h]	5.3[h]	105[i]	105[i]	105[i]
PFHxS	0.014[j]	0.014[j]	0.014[j]	NA[c]	NA[c]	NA[c]
PFOS	0.0327[k]	0.0327[k]	0.0327[k]	0.15[l]	0.15[l]	0.15[l]

[a] The presented TRVs (mg/kg-day) for the various surrogate species were derived from the test dose identified in the selected study for a corresponding test species after applying suitable values for uncertainty factors for extrapolating across species (UF_a), for extrapolating from sub-chronic to chronic exposures (UF_s), and for extrapolating from a LOAEL to a NOAEL (UF_l). The presented TRVs were calculated as the

test dose for the selected effect and endpoint from the selected study for the test species divided by the product of all three uncertainty factors as they apply.

[b] Das et al. (2008) – PFBA NOAEL of 35 mg/kg-day for reproduction and growth in mice for chronic (294-day) exposures converted to a TRV of 4.38 mg/kg-day after applying UF_a =8.

[c] NA = no suitable TRV value identified.

[d] Iwai and Hoberman (2014). PFHxA NOAEL of 100 mg/kg-day for mice pup development (bodyweight) for sub-chronic (18-day) exposures converted to a TRV of 4.17 mg/kg-day after applying UF_a =8 × UF_s =5 (UF_{tot} = 40).

[e] DeWitt et al. (2008). PFOA benchmark dose low (BMD-low) value of 1.75 mg/kg-day for immunomodulation effects in female mice in sub-chronic (15-day) exposures as derived as the TRV by Johnson et al. (2021) citing this study; the use of a sensitive endpoint in a sensitive test species required no further application of uncertainty factors for class Mammalia.

[f] Wolf et al. (2010). PFNA NOAEL of 0.83 mg/kg-day for reproductive effects in mice in sub-chronic (18-day) exposures converted to a TRV of 0.021 mg/kg-day after applying UF_a = 8 × UF_s = 5 (UF_{tot} = 40).

[g] Harris and Birnbaum (1989). PFDA NOAEL of 3 mg/kg-day for development (fetal bodyweight) in mice in sub-chronic (18-day) exposures converted to a TRV of 0.075 mg/kg-day after applying UF_a = 8 × UF_s = 5 (UF_{tot} = 40).

[h] Leider et al. (2009). PFBS NOAEL of 60 mg/kg-day for hematological effects in mice in sub-chronic (90-day) exposures converted to a TRV of 5.3 mg/kg-day by Johnson et al. (2021) citing this study after adjusting for the molecular weight of potassium in the salt form used in the study (60 × 0.8 = 53) and applying UF_{tot} = 10.

[I] Newsted et al. (2008). PFBS LOAEL of 3,160 mg/kg-day for growth (bodyweight) in bobwhite in acute exposures converted to a TRV of 105 mg/kg-day by Johnson et al. (2021) citing this study after applying UF_{tot} = 30.

[j] Chang et al. (2018). PFHxS LOAEL of 1 mg/kg-day for reproduction (litter size) in mice in sub-chronic (42-day) exposures converted to a TRV of 0.014 mg/kg-day after applying UF_a = 8 × UF_s = 3 × UF_l = 3 (UF_{tot} = 72).

[k] Thomford (2002). PFOS benchmark dose low (BMD-low) value of 0.0327 mg/kg-day for histopathological effects in male rats in chronic (104-week) exposures as derived as the TRV by Johnson et al. (2021) citing this study; the use of a sensitive endpoint in a sensitive test species required no further application of uncertainty factors for class Mammalia.

[l] Newsted et al. (2007); Gallagher et al. (2003a,b). PFOS NOAEL of 1.5 mg/kg-day for reproductive effects in bobwhite in chronic exposures converted to a TRV of 0.15 mg/kg-day by Johnson et al. (2021) citing these studies after applying UF_{tot} = 10.

C.3.1 References

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C.4 ESVs for Terrestrial Wildlife

The soil-based ESVs derived for terrestrial mammals and birds based on ingestion modeling are presented in Table C-4. Methods for derivation of the ESVs for terrestrial wildlife are described in Appendix A.

Table C-4 Soil-Based Ecological Screening Values (mg PFAS/kg soil) for Representative Terrestrial Mammals and Birds[a]

Compound	Mammalian Herbivore (Meadow Vole)	Mammalian Ground Invertivore (Short-tailed Shrew)	Mammalian Carnivore (Long-tailed Weasel)	Avian Granivore (Mourning Dove)	Avian Ground Invertivore (American Woodcock)	Avian Carnivore (Red-tailed Hawk)
Carboxylic Acids						
PFBA	6.23	**2.98**	32.3	--[b]	--[b]	--[b]
PFHxA	12.8	**6.20**	18.4	--[b]	--[b]	--[b]
PFOA	141	**3.84**	12.9	--[b]	--[b]	--[b]
PFNA	0.209	**0.0242**	0.153	--[b]	--[b]	--[b]
PFDA	1.17	**0.0677**	0.553	--[b]	--[b]	--[b]
Sulfonic Acids						
PFBS	16.7	**0.817**	39.1	148	**15.8**	2,820
PFHxS	0.104	**0.0028**	0.102	--[b]	--[b]	--[b]
PFOS	0.540	**0.0087**	0.023	0.988	**0.0386**	0.384

[a] The minimum soil-based ESV for each PFAS for both mammals and birds is identified using bold text.

[b] Insufficient data were available to develop an ESV.

APPENDIX D: AQUATIC LIFE

D.1 FRESHWATER

D.1.1 PFBA

Table D.1.1-1 PFBA Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Species Common Name	Species Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Brachionidae	*Brachionus*	Rotifer	*Brachionus calyciflorus*	Mortality	LC50	110	Not reported	Static	Neonate	1	Wang et al. 2014	175717	41
Chydoridae	*Chydorus*	Daphnid	*Chydorus sphaericus*	Mortality	EC50	462	Unmeasured	Static	Neonate	2	Ding et al. 2012.	a0620	46
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	>3,000	Unmeasured	Static	Embryo	4	Hagenaars et al 2011	152104	11
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Multiple	EC50	2,200	Unmeasured	Static	Embryo	6	Ulhaq et al. 2013	165818	9
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	13,795	Unmeasured	Renewal	Gastrula	4	Godfrey et al. 2017	177139	14
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	>1,006	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	7
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	EC50	182	Unmeasured	Static	Neonate	2	Ding et al. 2012.	a0620	50
Daphniidae	*Daphnia*	Water flea	*Daphnia pulicaria*	Mortality	LC50	>1,006	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	6

Table D.1.1-2 PFBA Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Brachionidae	*Brachionus*	110,000
Chydoridae	*Chydorus*	462,000
Cyprinidae	*Danio*	4,498,715
Daphniidae	*Daphnia*	656,087

Table D.1.1-3 PFBA Freshwater ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV (µg/L)	**110,000**	**Plant Values (IC/EC50, µg/L)**		
Number of Tier I taxa out of 8	4	*Pseudokircheriella*	262,198	Ding et al. 2012
Secondary Acute Factor (SAF)	7	*Pseudokircheriella*	620,715	Boudreau 2002
Secondary Acute Value (SAV) (µg/L)	15,714	*Chlorella*	727,735	Boudreau 2002
Secondary Acute Chronic Ratio (SACR)[a]	243			
Secondary Chronic Value (SCV) (µg/L)	64.6			
Final Plant Value (FPV) (µg/L)	262,198			
Exposure ESV (µg/L)	**64.6**			

[a] ACR based on 90th percentile of the species ACRs calculated for PFOA (see Table D.1.3-3).

D.1.2 PFHxA

Table D.1.2-1 PFHxA Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Species Common Name	Species Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Brachionidae	*Brachionus*	Rotifer	*Brachionus calyciflorus*	Mortality	LC50	140	Not reported	Static	Neonate	1	Wang et al. 2014	175717	20
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	91.1	Unmeasured	Static	Embryo	5	Annunziato et al. 2019	178562	13

Table D.1.2-2 PFHxA Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Brachionidae	*Brachionus*	140,000
Cyprinidae	*Danio*	91,076

Table D.1.2-3 PFHxA Freshwater ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	91,076	Plant Values (EC50, µg/L)		
Number of Tier I taxa out of 8	2	*Skeletonema marinoi*	1,482,340	Latala et al. 2009
Secondary Acute Factor (SAF)	13	*Scenedesmus acutus* var. *acutus*	628,110	Liu et al. 2008
Secondary Acute Value (SAV) (µg/L)	7,006	*Chlorella vulgaris*	4,032,468	Latala et al. 2009
Secondary Acute Chronic Ratio (SACR)[a]	243			
Secondary Chronic Value (SCV) (µg/L)	28.8			
Final Plant Value (FPV) (µg/L)	682,110			
Chronic Exposure ESV (µg/L)	**28.8**			

[a] ACR based on 90th percentile of the species ACRs calculated for PFOA (see Table D.1.3-3).

D.1.3 PFOA

Table D.1.3-1 PFOA Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Brachionidae	*Brachionus*	Rotifer	*Brachionus calyciflorus*	Mortality	LC50	150	Reported	Static	Neonate	1	Zhang et al. 2013	175669	660
Ranidae	*Bufo*	Asiatic toad	*Bufo gargarizans*	Mortality	LC50	114.7	Reported	Static	Tadpole	4	Yang et al. 2014	175260	49
Cyprinidae	*Carassius*	Goldfish	*Carassius auratus*	Mortality	LC50	606.6	Reported	Static	Not reported	4	Yang et al. 2014	175260	273
Chironomidae	*Chironomus*	Midge	*Chironomus plumosus*	Mortality	LC50	402.2	Reported	Static	Larva	4	Yang et al. 2014	175260	330
Viviparidae	*Cipangopa-ludina*	Snail	*Cipangopaludina cathayensis*	Mortality	LC50	740	Reported	Static	Not reported	4	Yang et al. 2014	175260	688
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	473	Unmeasured	Renewal	Gastrula	4	Godfrey et al. 2017	177139	141
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	386.3	Unmeasured	Renewal	Egg	4	Ding et al. 2013	175221	936
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	262	Unmeasured	Not reported	Embryo	0.33	Zheng et al. 2012	160547	139
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Multiple	EC50	205.7	Unmeasured	Static	Embryo	4	Hagenaars et al. 2011	152104	137
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	24.6	Unmeasured	Not reported	Embryo	4	Corrales et al. 2017	177136	144
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Deformation Development	EC50	759	Unmeasured	Renewal	Embryo	4	Stengel et al. 2018	176328	135
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	201.8	Reported	Static	Not reported	2	Yang et al. 2014	175260	106
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	268.7	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	105
Daphniidae	*Daphnia*	Water flea	*Daphnia pulicaria*	Mortality	LC50	276.6	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	70
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	LC50	337	Unmeasured	Not reported	Not reported	4	Li 2009	118450	971
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	LC50	39.3	Unmeasured	Renewal	Not reported	4	Yuan et al. 2015	177055	700
Centrarchidae	*Lepomis*	Bluegill	*Lepomis macrochirus*	Mortality	LC50	634	Unmeasured	Not reported	Not reported	4	Dupont Haskell Lab 2000	151364	934
Tubificidae	*Limnodrilus*	Redworm	*Limnodrilus hoffmeisteri*	Mortality	LC50	568.2	Reported	Static	Not reported	4	Yang et al. 2014	175260	696
Palaemonidae	*Macrobrachium*	Oriental river prawn	*Macrobrachium nipponense*	Mortality	LC50	366.6	Reported	Static	Not reported	4	Yang et al. 2014	175260	69
Atyidae	*Neocaridina*	Cherry shrimp	*Neocaridina denticulata*	Mortality	LC50	454	Unmeasured	Not reported	Not reported	4	Li 2009	118450	895
Salmonidae	*Oncorhynchus*	Rainbow trout	*Oncorhynchus mykiss*	Mortality	LC50	707	Unmeasured	Static	Not reported	4	Colombo et al. 2008	151611	948
Salmonidae	*Oncorhynchus*	Rainbow trout	*Oncorhynchus mykiss*	Mortality	LC50	4001	Measured	Static	Not reported	4	Dupont Haskell Lab 2000	151364	947

Table D.1.3-1 PFOA Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Physidae	*Physella*	European physa	*Physella acuta*	Mortality	LC50	672	Unmeasured	Not reported	Not reported	4	Li 2009	118450	961
Cyprinidae	*Pimephales*	Fathead minnow	*Pimephales promelas*	Mortality	LC50	413.2	Unmeasured	Not reported	Larva	4	Corrales, et al. 2017	177136	145
Cyprinidae	*Pseudorasbora*	Stone moroco	*Pseudorasbora parva*	Mortality	LC50	365	Reported	Static	Not reported	4	Yang, et al. 2014	175260	126
Pipidae	*Xenopus*	Clawed frog	*Xenopus* sp.	Abnormal (Morphology)	EC50	257.6	Unmeasured	Renewal	Blastula	4	Kim, et al. 2013	170608	47

Table D.1.3-2 PFOA Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)	Rank
Ranidae	*Bufo*	114,740	1
Dugesiidae	*Dugesia*	115,156	2
Brachionidae	*Brachionus*	150,000	3
Cyprinidae	*Danio*	238,461	4
Daphniidae	*Daphnia*	253,812	5
Pipidae	*Xenopus*	257,635	6
Cyprinidae	*Pseudorasbora*	365,020	7
Palaemonidae	*Macrobrachium*	366,660	8
Chironomidae	*Chironomus*	402,240	9
Cyprinidae	*Pimephales*	413,200	10
Atyidae	*Neocaridina*	454,000	11
Tubificidae	*Limnodrilus*	568,200	12
Cyprinidae	*Carassius*	606,610	13
Centrarchidae	*Lepomis*	634,000	14
Physidae	*Physella*	672,000	15
Viviparidae	*Cipangopaludina*	740,070	16
Salmonidae	*Oncorhynchus*	1,681,876	17

Table D.1.3-3 PFOA Derivation of Final Acute-to-Chronic Ratio (ACR) (per EPA 2012 Tier I Methodology)

PFOA Species	Common Name	Acute LC50 mg/L	Acute EC50 mg/L	Acute EC10 mg/L	Acute LOEC mg/L	Chronic NOEC mg/L	Chronic EC10 mg/L	Chronic LOEC mg/L	Endpoint	Source	Acute mg/L	Chronic mg/L	SACR[b]
Bufo gargizans	Asiatic toad	114.74					5.89		Survival	Yang et al. 2014	114.74	5.89	19.5
Daphnia magna	Daphnia	201.85					7.02		acute mortality/repro chronic	Yang et al. 2014	201.85	7.02	28.8
Pseudorasbora parva	Stone moroco	365.02					11.78		Survival	Yang et al. 2014	365.02	11.78	31.0
Brachionus	Rotifer	150						0.5	Reproduction	Zhang et al 2013	150	0.5	**300**
Danio rerio	Zebra danio		205.72			1			Mortality Reproduction	Hagenaars et al 2011	205.72	1	206
Moina macrocopa	Daphnid		199.51		125	3.125		6.25	Mortality	Ji et al. 2008	199.51	4.42	45.1
Oncorhynchus	Rainbow Trout	707			250	40			Multiple	Columbo et al 2008	707	40	17.7
												Final ACR[a] =	**300**

[a] Final PFOA ACR = ACR for *Brachionus*.(300) as a conservative ACR for a species with a genus mean acute value (150 mg/L) near the final acute value (92 mg/L).
[b] The 90th percentile of the PFOA SACRs of **243** was selected as a conservative default ACR for PFCAs other than PFOA assuming chemical class similarity in ACRs.

Table D.1.3-4 PFOA Freshwater ESV Derivation (per EPA 2012 Tier I Methodology)

Number of Tier I taxa out of 8	**8**	**Plant Values (µg/L)**			
Final Acute Value (µg/L) =	92,146	*Clamydomonas*	EC50	51,900	Hu et al. 2014
Final Acute Chronic Ratio	300	*Chlorella*	EC50	190,990	Xu et al. 2013
Final Plant Value (µg/L)	44,000	*Pseudokirchinella*	EC50	207,460	Xu et al. 2013
		Scenedesmus	EC50	44,000	Hu et al. 2014
		Scenedesmus	EC50	269,630	Yang et al. 2014
Chronic Exposure ESV (µg/L)	**307**	*Lemna*	IC50	46,376	Boudreau 2002

D.1.4 PFNA

Table D.1.4-1 PFNA Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Chydoridae	*Chydorus*	Daphnid	*Chydorus sphaericus*	Mortality	EC50	28	Unmeasured	Static	Neonate	2	Ding et al. 2012	a0620	97
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	84	Unmeasured	Not reported	Embryo	3	Zheng et al. 2012	160547	57
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	>10	Unmeasured	Static	Embryo	6	Ulhaq et al. 2013	165818	59
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	EC50	151	Unmeasured	Static	Neonate	2	Ding et al. 2012	a0620	101
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	120.2	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	24
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	80.9	Unmeasured	Static	Neonate	2	Lu et al. 2015	177104	25
Pipidae	*Xenopus*	Clawed frog	*Xenopus* sp.	Abnormal	EC50	234.9	Unmeasured	Renewal	Blastula	4	Kim et al. 2013	170608	7

Table D.1.4-2 PFNA Genus Geomeans Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Chydoridae	*Chydorus*	28,000
Cyprinidae	*Danio*	28,983
Daphniidae	*Daphnia*	113,674
Pipidae	*Xenopus*	234,870

Table D.1.4-3 PFNA Freshwater ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	**28,000**	**Plant Values (IC50, µg/L)**		
Number of Tier I taxa out of 8	4	*Lemna*	89,103	Boudreau 2002
Secondary Acute Factor (SAF)	7			
Secondary Acute Value (SAV) (µg/L)	4,000			
Secondary Acute Chronic Ratio (SACR)[a]	243			
Secondary Chronic Value (SCV) (µg/L)	16.4			
Final Plant Value (FPV) (µg/L)	89,103			
Chronic Exposure ESV (µg/L)	**16.4**			

[a] ACR based on 90th percentile of the species ACRs calculated for PFOA (see Table D.1.3-3).

D.1.5 PFDA

Table D.1.5-1 PFDA Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Multiple	EC50	5	Unmeasured	Static	Embryo	6	Ulhaq et al. 2013	165818	22
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	258.6	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	21
Daphniidae	*Daphnia*	Water flea	*Daphnia pulicaria*	Mortality	LC50	284.8	Unmeasured	Static	Not reported	2	Boudreau 2002	175259	20
Salmonidae	*Oncorhynchus*	Rainbow trout	*Oncorhynchus mykiss*	Mortality	LC50	32	Unmeasured	Static	Not reported	4	Hok, et al. 2012	161077	43
Pipidae	*Xenopus*	Clawed frog	*Xenopus* sp.	Abnormal (Morphology)	EC50	59.3	Unmeasured	Renewal	Blastula	4	Kim et al. 2013	170608	11

Table D.1.5-2 PFDA Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Cyprinidae	*Danio*	5,000
Salmonidae	*Oncorhynchus*	32,000
Pipidae	*Xenopus*	59,325
Daphniidae	*Daphnia*	271,378

Table D.1.5-3 PFDA Freshwater ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	5,000	Plant Values (IC50/EC50, µg/L)		
Number of Tier I taxa out of 8	4	*Chlorella*	198,440	Boudreau 2002
Secondary Acute Factor (SAF)	7	*Pseudokircheriella*	218,490	Boudreau 2002
Secondary Acute Value (SAV) (µg/L)	714	*Pseudokircheriella*	10,600	Hoke et al. 2012
Secondary Acute Chronic Ratio (SACR)[a]	243	*Lemna*	99,220	Boudreau 2002
Secondary Chronic Value (SCV) (µg/L)	2.94			
Final Plant Value (FPV) (µg/L)	10,600			
Chronic Exposure ESV (µg/L)	**2.94**			

[a] ACR based on 90th percentile of the species ACRs calculated for PFOA (see Table D.1.3-3).

D.1.6 PFBS

Table D.1.6-1 PFBS Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Multiple	EC50	1,529	Unmeasured	Static	Embryo	4	Hagenaars et al. 2011	152104	8
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Multiple	EC50	450	Unmeasured	Static	Embryo	6	Ulhaq et al. 2013	165818	5

Table D.1.6-2 PFBS Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Cyprinidae	*Danio*	829,574

Table D.1.6-3 PFBS Freshwater EVS Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	**829,574**	**Plant Values (EC50, µg/L)**		
Number of Tier I taxa out of 8	1	Pseudokirchneriella	>20,250,000	Rosal et al. 2010
Secondary Acute Factor (SAF)	21.90			
Secondary Acute Value (SAV) (µg/L)	37,880			
Secondary Acute Chronic Ratio (SACR)[a]	94.8			
Secondary Chronic Value (SCV) (µg/L)	400			
Final Plant Value (FPV) (µg/L)	20,250,000			
Chronic Exposure ESV (µg/L)	**400**			

[a] ACR based on 90th percentile ACR calculated for PFOS (see Table D.1.8-3).

D.1.7 PFHxS

Table D.1.7-1 PFHxS Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	135.7	Unmeasured	Static	Embryo	5	Annunziato et al. 2019	178562	10

Table D.1.7-2 PFHxS Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Cyprinidae	*Danio*	135,695

Table D.1.7-3 PFHxS Freshwater ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	**135,695**
Number of Tier I taxa out of 8	1
Secondary Acute Factor (SAF)	21.9
Secondary Acute Value (SAV) (µg/L)	6,196
Secondary Acute Chronic Ratio (SACR)[a]	94.8
Secondary Chronic Value (SCV) (µg/L)	65.3
Final Plant Value (FPV) (µg/L)	Not available
Chronic Exposure ESV (µg/L)	**65.3**

[a] ACR based on 90th percentile ACR calculated for PFOS (see Table D.1.8-3).

D.1.8 PFOS

Table D.1.8-1 PFOS Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Cyprinidae	*Carassius*	Goldfish	*Carassius auratus*	Mortality	LC50	81.2	Reported	Static	Not reported	4	Yang et al. 2014	175260	924
Chironomidae	*Chironomus*	Midge	*Chironomus plumosus*	Mortality	LC50	182.1	Reported	Static	Larva	4	Yang et al. 2014	175260	1111
Viviparidae	*Cipangopaludina*	Snail	*Cipangopaludina cathayensis*	Mortality	LC50	247.1	Reported	Static	Not reported	4	Yang et al. 2014	175260	1224
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	38.9	Reported	Renewal	Embryo	2	Sharpe et al. 2010	151619	740
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	34.2	Unmeasured	Renewal	Embryo	4	Stengel et al. 2017	175499	69
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	54.5	Unmeasured	Renewal	Egg	4	Ding et al. 2013	175221	736
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	68	Unmeasured	Aquatic - not reported	Embryo	3	Zheng et al. 2012	160547	60
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	58.5	Unmeasured	Static	Embryo	4	Hagenaars et al. 2011	152104	742
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	7.7	Reported	Renewal	Embryo	2	Sharpe et al. 2010	151619	739
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	LC50	3.50	Unmeasured	Static	Embryo	4	Du et al. 2016	177124	735
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	78.1	Reported	Static	Not reported	2	Yang et al. 2014	175260	541
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	EC50	61	Measured	Static	Neonate	2	Drottar and Krueger 2000	175365	536
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Survival	LC50	130	Unmeasured	Static	Neonate	2	Boudreau et al. 2003	71875	548
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	LC50	49.3	Unmeasured	Static	Neonate	2	Lu et al. 2015	177104	1332
Daphniidae	*Daphnia*	Water flea	*Daphnia pulicaria*	Survival	LC50	169	Unmeasured	Static	Neonate	2	Boudreau et al. 2003	71875	473
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	LC50	29.46	Unmeasured	Renewal	Not reported	4	Yuan et al. 2014	175659	1260
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	LC50	17	Unmeasured	Static	Not reported	4	Li 2008	111070	1581
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	LC50	23	Unmeasured	Aquatic - not reported	Not reported	4	Li 2009	118450	1255
Unionidae	*Elliptio*	Eastern elliptio	*Elliptio complanata*	Mortality	LC50	59	Measured	Renewal	Not reported	4	Drottar and Krueger 2000	175369	1231
Unionidae	*Ligumia*	Black sandshell	*Ligumia recta*	Survival	EC50	141.7	Unmeasured	Renewal	Juvenile	4	Hazelton et al. 2012	160209	257

Table D.1.8-1 PFOS Freshwater Acute LC/EC50 Values for Aquatic ESV Derivation

Family	Genus	Common Name	Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Tubificidae	*Limnodrilus*	Redworm	*Limnodrilus hoffmeisteri*	Mortality	LC50	23.8	Unmeasured	Renewal	Not reported	2	Qu et al. 2016	175703	1253
Tubificidae	*Limnodrilus*	Redworm	*Limnodrilus hoffmeisteri*	Mortality	LC50	121	Reported	Static	Not reported	4	Yang et al. 2014	175260	1252
Palaemonidae	*Macrobrachium*	Oriental river prawn	*Macrobrachium nipponense*	Mortality	LC50	19.8	Reported	Static	Not reported	4	Yang et al. 2014	175260	472
Atyidae	*Neocaridina*	Cherry shrimp	*Neocaridina denticulata*	Mortality	LC50	10	Unmeasured	Aquatic - not reported	Not reported	4	Li 2009	118450	475
Salmonidae	*Oncorhynchus*	Rainbow trout	*Oncorhynchus mykiss*	Mortality	LC50	2.5	Reported	Renewal	Parr	4	Sharpe et al. 2010	151619	927
Physidae	*Physella*	European physa	*Physella acuta*	Mortality	LC50	178	Unmeasured	Aquatic - not reported	Not reported	4	Li 2009	118450	1228
Cyprinidae	*Pseudorasbora*	Stone moroco	*Pseudorasbora parva*	Mortality	LC50	67.7	Reported	Static	Not reported	4	Yang et al. 2014	175260	671

Table D.1.8-2 PFOS Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)	Rank
Salmonidae	*Oncorhynchus*	2,500	1
Atyidae	*Neocaridina*	10,000	2
Palaemonidae	*Macrobrachium*	19,770	3
Dugesiidae	*Dugesia*	22,584	4
Cyprinidae	*Danio*	25,876	5
Tubificidae	*Limnodrilus*	53,668	6
Unionidae	*Elliptio*	59,000	7
Cyprinidae	*Pseudorasbora*	67,740	8
Cyprinidae	*Carassius*	81,180	9
Daphniidae	*Daphnia*	112,073	10
Unionidae	*Ligumia*	141,700	11
Physidae	*Physella*	178,000	12
Chironomidae	*Chironomus*	182,120	13
Viviparidae	*Cipangopaludina*	247,140	14

Table D.1.8.-3 PFOS Derivation of Final Acute-to-Chronic Ratio (ACR) (per EPA 2012 Tier I Methodology)

PFOS		Acute				Chronic							
Species	Common Name	LC50 mg/L	EC50 mg/L	EC10 mg/L	NOEC mg/L	LC10 EC10 mg/L	LOEC mg/L	Endpoint	Source	Acute	Geomean Chronic	SACR	Geomean SACR
Pseudorasbora	Stone morocco	67.74				2.12		Mortality	Yang et al. 2014	67.74	2.12	31.95	
Daphnia magna	Water flea		61	53		4.17		Mortality	Drottar and Kreuger 2000	61	4.17	14.62	
	Water flea		37.36		0.625		1.25	Survival	Ji et al. 2008	37.36	0.88[a]	42.45	
	Water flea		67.2			5.3		Survival immobilization	Boudreau et al. 2003	67.2	5.3	12.68	
	Water flea		78.09			2.26		Survival, Reproduction	Yang et al. 2014	78.09	2.26	34.55	22.83
Bufo gargarizans	Asiatic toad	48.21				2		Survival	Yang et al. 2014	48.21	2	24.10	
Procambarus fallax f. virginalis	Crayfish		59.87				0.5	Survival	Funkhouser 2014	59.87	0.5	119.74	
Moina	Daphnid		17.95		<0.3125		0.3125	Survival	Ji et al. 2008	17.95	0.3125	57.44	
											Final ACR[b]	**94.8**	

[a] Calculated as geomean of the NOEC and LOEC.
[b] Calculated as the 90th percentile of the individual SACRs and the geomean SACR for *Daphnia*; this value (94.8) was selected as a conservative default ACR for PFSAs assuming chemical class similarity in ACRs.

Table D.1.8-4 PFOS Freshwater ESV Derivation (per EPA 2012 Tier I Methodology)

			Plant Values (µg/L)	
# of Tier I taxa out of 8	8	*Lemna*	31,100	Boudreau et al. 2003
Final Acute Value (µg/L)	2,139	Green algae	71,000	Drottar 2000
Final Acute Chronic Ratio	94.8	*Scenedesmus*	77,800	Liu et al. 2008
Final Plant Value (µg/L)	31,100	*Pseudokirchneriella*	35,000	Rosal et al. 2010
Chronic Exposure ESV (ug/L)	**22.6**			

D.2 MARINE

D.2.1 PFOA MARINE

Table D.2.1-1 PFOA Marine Acute LC/EC50 Values for Aquatic Derivation

Family	Genus	Species Common Name	Species Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Scophthalmidae	*Psetta*	Turbot	*Psetta maxima*	Multiple	EC50	11.9	Unmeasured	Renewal	Embryo	6	Mhadhbi et al. 2012	160548	125
Mysidae	*Siriella*	Mysid shrimp	*Siriella armata*	Mortality	EC50	15.5	Unmeasured	Static	Neonate	4	Mhadhbi et al. 2012	160548	68
Parechinidae	*Paracentrotus*	Sea urchin	*Paracentrotus lividus*	Length (Growth)	EC50	110	Unmeasured	Static	Embryo	2	Mhadhbi et al. 2012	160548	659

Table D.2.1.-2 PFOA Marine Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Scophthalmidae	*Psetta*	11,900
Mysidae	*Siriella*	15,500
Parechinidae	*Paracentrotus*	110,000

Table D.2.1-3 PFOA Marine ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	11,900	Plant Values (EC50, µg/L)		
Number of Tier I taxa out of 8	3	*Isochrysis galbana*	163,600	Mhadhbi et al. 20012
Secondary Acute Factor (SAF)	8	*Skeletonema marinoi*	368,523	Latala et al. 2009
Secondary Acute Value (SAV) (µg/L)	1,487	*Geitlerinema amphibium*	248,442	Latala et al. 2009
Secondary Acute Chronic Ratio (SACR)[a]	243	*Chlorella vulgaris*	977,207	Latala et al. 2009
Secondary Chronic Value (SCV) (µg/L)	6.12			
Final Plant Value (FPV) (µg/L)	163,600			
Chronic Exposure ESV (µg/L)	**6.12**			

[a] ACR based on 90th percentile of the species freshwater ACRs calculated for PFOA (see Table D.1.3-3).

D.2.2 PFOS MARINE

Table D.2.2-1 PFOS Marine Acute LC/EC50 Values for Aquatic Derivation

Family	Genus	Common Name	Species Scientific Name	Effect Measurement	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Ostreidae	*Crassostrea*	Eastern oyster	*Crassostrea virginica*	Shell deposition (Morphology)	EC50	>3	Measured	Static	Not Reported	4	Drottar and Krueger 2000	175360	1240
Mysidae	*Siriella*	Mysid shrimp	*Siriella armata*	Mortality	EC50	6.9	Unmeasured	Static	Neonate	4	Mhadhbi et al. 2012	160548	13
Parechinidae	*Paracentrotus*	Sea urchin	*Paracentrotus lividus*	Length (Growth)	EC50	20	Unmeasured	Static	Embryo	2	Mhadhbi et al. 2012	160548	251
Parechinidae	*Paracentrotus*	Sea urchin	*Paracentrotus lividus*	Slowed, Retarded, Delayed or Non-development	EC50	1.80	Unmeasured	Static	Embryo	3	Gunduz et al. 2013	176044	1549

Table D.2.2-2 PFOS Marine Genus Geomeans of Acute LC/EC50 Values

Family	Genus	Genus Geomean (µg/L)
Ostreidae	*Crassostrea*	3,000
Parechinidae	*Paracentrotus*	5,992
Mysidae	*Siriella*	6,900

Table D.2.2-3 PFOS Marine ESV Derivation (per EPA 2012 Tier II Methodology)

Lowest GMAV	**3,000**
Number of Tier I taxa out of 8	3
Secondary Acute Factor (SAF)	8.0
Secondary Acute Value (SAV) (µg/L)	375
Secondary Acute Chronic Ratio (SACR)[a]	**94.8**
Secondary Chronic Value (SCV) (µg/L)	3.96
Final Plant Value (FPV) (µg/L)	Not available
Chronic Exposure ESV (µg/L)	**3.96**

[a] ACR based on 90th percentile ACR calculated for PFOS (see Table D.1.8-3).

D.3 FRESHWATER NOEC HC5 VALUES

D.3.1 PFOA NOEC HC5 VALUES

Table D.3.1-1 PFOA Freshwater NOEC Values

Family	Genus	Common Name	Scientific Name	Effect	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Brachionidae	Brachionus	Rotifer	*Brachionus calyciflorus*	Mortality	NOEC	0.125	Unmeasured	Renewal	Neonate	6	Zhang et al. 2014	168456	676
Brachionidae	Brachionus	Rotifer	*Brachionus calyciflorus*	Development	NOEC	0.25	Reported	Renewal	Neonate	NR	Zhang et al. 2013	175669	675
Ranidae	Bufo	Asiatic toad	*Bufo gargarizans*	Growth	NOEC	38.0	Reported	Renewal	Tadpole	30	Yang et al. 2014	175260	52
Subclass Copepoda	Cyclops	Cyclopoid	*Cyclops sp.*	Population	NOEC	30	Unmeasured	Static	Not reported	7	Sanderson et al. 2003	68253	84
Cyprinidae	Danio	Zebra danio	*Danio rerio*	Growth	NOEC	0.083	Unmeasured	Static	Embryo	4.9	Jantzen et al. 2016	175223	252
Cyprinidae	Danio	Zebra danio	*Danio rerio*	Mortality	NOEC	50	Unmeasured	Static	Embryo	NR	Hagenaars et al. 2011	152104	190
Cyprinidae	Danio	Zebra danio	*Danio rerio*	Mortality	NOEC	>1000	Unmeasured	Static	Embryo	NR	Ulhaq et al. 2013	165818	256
Cyprinidae	Danio	Zebra danio	*Danio rerio*	Mortality	NOEC	200	Unmeasured	Not reported	Embryo	2	Zheng et al. 2012	160547	258
Cyprinidae	Danio	Zebra danio	*Danio rerio*	Development	NOEC	0.41	Unmeasured	Static	Larva	4	Kalasekar et al. 2015	172976	185
Daphniidae	Daphnia	Water flea	*Daphnia magna*	Reproduction	NOEC	20	Measured	Renewal	Neonate	21	Colombo et al. 2008	151611	922
Daphniidae	Daphnia	Water flea	*Daphnia magna*	Reproduction	NOEC	38.0	Reported	Renewal	Not reported	21	Yang et al. 2014	175260	111
Daphniidae	Daphnia	Water flea	*Daphnia magna*	Reproduction	NOEC	3.2	Unmeasured	Renewal	Juvenile	1	Li 2010	152183	924
Daphniidae	Daphnia	Water flea	*Daphnia magna*	Population	NOEC	10	Unmeasured	Static	Not reported	1	Sanderson et al. 2003	68253	116
Dugesiidae	Dugesia	Planaria	*Dugesia japonica*	Growth	NOEC	1	Unmeasured	Renewal	Not reported	5	Yuan et al. 2015	177055	712
Dugesiidae	Dugesia	Planaria	*Dugesia japonica*	Mortality	NOEC	400	Unmeasured	Static	Not reported	4	Li 2008	111070	982
Dugesiidae	Dugesia	Planaria	*Dugesia japonica*	Mortality	NOEC	150	Unmeasured	Not reported	Not reported	1	Li 2009	118450	980
Ranidae	Lithobates (Rana)	Northern leopard frog	*Lithobates pipiens*	Development	NOEC	1	Reported	Renewal	Tadpole	20	Hoover et al. 2017	176982	58
Moinidae	Moina	Water flea	*Moina macrocopa*	Reproduction	NOEC	3.12	Unmeasured	Renewal	Neonate	7	Ji et al. 2008	114976	79
Atyidae	Neocaridina	Cherry shrimp	*Neocaridina denticulata*	Mortality	NOEC	250	Unmeasured	Not reported	Not reported	2	Li 2009	118450	899
Salmonidae	Oncorhynchus	Rainbow trout	*Oncorhynchus mykiss*	Mortality	NOEC	40	Measured	Flow-through	Egg	85	Colombo et al. 2008	151611	951
Adrianichthyidae	Oryzias	Japanese rice fish	*Oryzias latipes*	Reproduction	NOEC	3	Reported	Renewal	Adult	119	Lee et al. 2017	177079	210

Table D.3.1-1 PFOA Freshwater NOEC Values

Family	Genus	Common Name	Scientific Name	Effect	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Adrianichthyidae	Oryzias	Japanese rice fish	*Oryzias latipes*	Mortality	NOEC	1	Unmeasured	Renewal	Adult	28	Ji et al. 2008	114976	189
Physidae	Physella	European physa	*Physella acuta*	Mortality	NOEC	250	Unmeasured	Not reported	Not reported	4	Li 2009	118450	966
Cyprinidae	Pseudorasbora	Stone moroco	*Pseudorasbora parva*	Growth	NOEC	75.9	Reported	Renewal	Not reported	30	Yang et al. 2014	175260	128
Pipidae	Xenopus	Clawed frog	*Xenopus sp.*	Growth	NOEC	104	Unmeasured	Renewal	Blastula	4	Kim et al. 2013	170608	51

Table D.3.1-2 PFOA Mean Species NOECs for Deriving HC5 Value using GLI Equations

Family	Genus	Common Name	Genus Geomean (µg/L)	Rank
Brachionidae	Brachionus	Rotifer	177	1
Ranidae	Lithobates (Rana)	Northern leopard frog	1,000	2
Adrianichthyidae	Oryzias	Japanese rice fish	1,732	3
Moinidae	Moina	Water flea	3,125	4
Daphniidae	Daphnia	Water flea	12,485	5
Cyprinidae	Danio	Zebra danio	12,795	6
Subclass Copepoda	Cyclops	Cyclopoid	30,000	7
Ranidae	Bufo	Asiatic toad	37,970	8
Dugesiidae	Dugesia	Planaria	39,149	9
Salmonidae	Oncorhynchus	Rainbow trout	40,000	10
Cyprinidae	Pseudorasbora	Stone moroco	75,940	11
Pipidae	Xenopus	Clawed frog	103,518	12
Physidae	Physella	European physa	250,000	13
Atyidae	Neocaridina	Cherry shrimp	250,000	14

Table D.3.1-3 PFOA Freshwater NOEC HC5 using GLI equations (µg/L)

Number of families	12
HC5 =	**143.6**

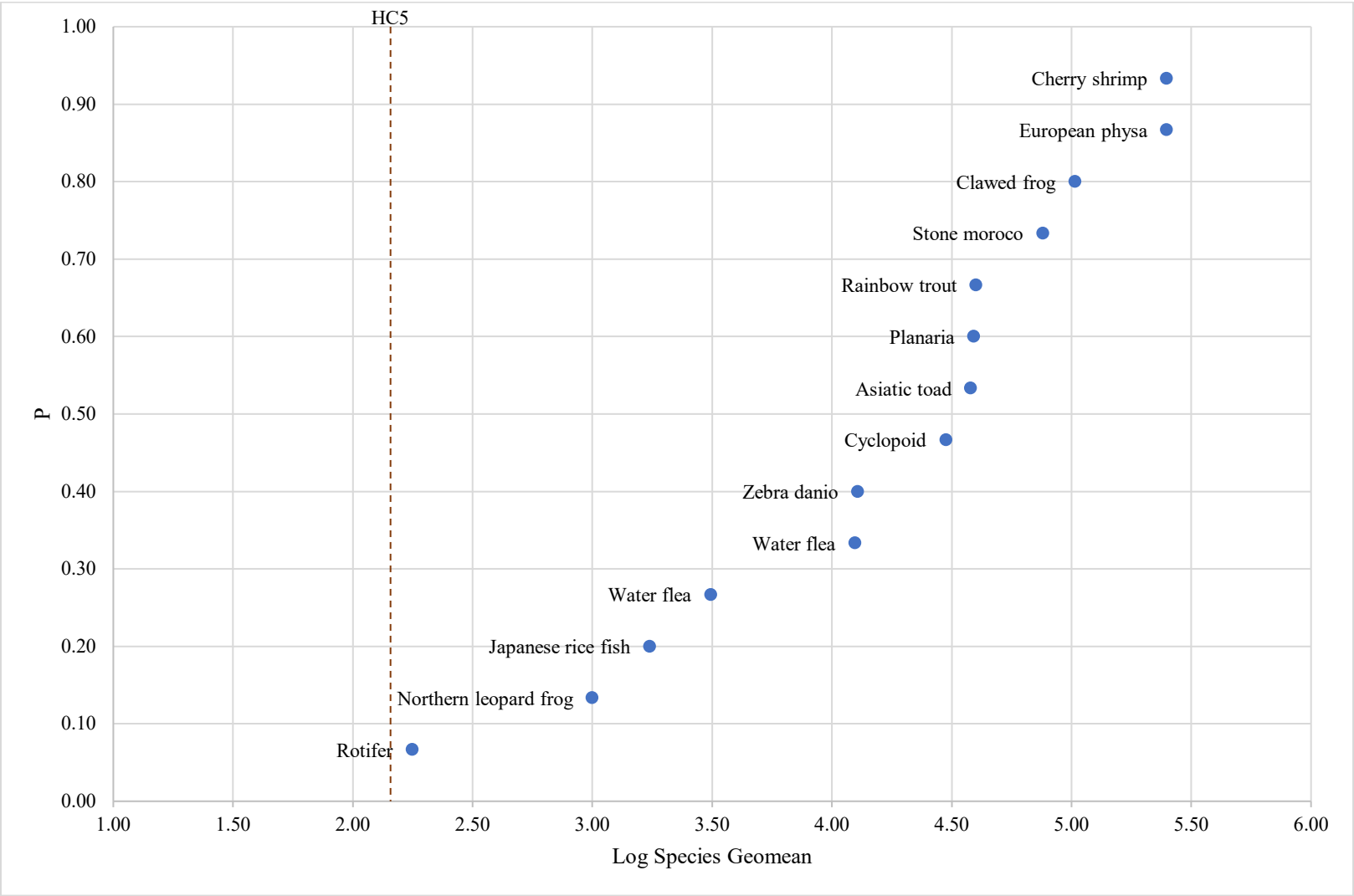

Figure D.3-1 PFOA Freshwater NOEC Species Sensitivity Distribution Showing HC5 Derived Using GLI Equations

D.3.2 PFOS NOEC HC5 VALUES

Table D.3.2-1 PFOS Freshwater NOEC Values

Family	Genus	Common Name	Scientific Name	Effect	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Brachionidae	*Brachionus*	Rotifer	*Brachionus calyciflorus*	Population	NOEC	0.5	Reported	Renewal	Neonate	NR	Zhang et al. 2013	175669	1567
Chironomidae	*Chironomus*	Midge	*Chironomus tentans*	Mortality	NOEC	0.022	Measured	Renewal	Larva	20	MacDonald et al. 2004	87173	1129
Cyprinidae	*Cyprinus*	Common carp	*Cyprinus carpio*	Morphology	NOEC	0.1	Unmeasured	Renewal	Juvenile	14	Hagenaars et al. 2008	114715	1592
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.17	Measured	Renewal	Embryo	4	Wang et al. 2017	175190	819
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	NOEC	0.5	Unmeasured	Static	Embryo	3	Shi et al. 2008	114603	1380
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.2	Unmeasured	Renewal	Embryo	15	Shi et al. 2009	119304	862
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Morphology	NOEC	0.4	Unmeasured	Static	Embryo	4	Du et al. 2016	177124	885
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.5	Unmeasured	Static	Embryo	5	Hagenaars et al. 2011	152104	900
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Morphology	NOEC	8.0	Unmeasured	Renewal	Embryo	7	Sant et al. 2017	175217	188
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Morphology	NOEC	8.0	Unmeasured	Renewal	Blastula	3.9	Sant et al. 2018	178022	151
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	NOEC	>10	Unmeasured	Static	Embryo	NR	Ulhaq et al. 2013	165818	177
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Development	NOEC	8.00	Unmeasured	Static	Embryo	4	Chen et al. 2014	168368	140
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Development	NOEC	0.50	Unmeasured	Renewal	Embryo	4	Dang et al. 2018	178026	206
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.7	Unmeasured	Renewal	Egg	6	Hagenaars et al. 2014	175658	855
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Mortality	NOEC	4	Unmeasured	Static	Embryo	1.75	Huang et al. 2010	151614	180
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.050	Unmeasured	Renewal	Embryo	180	Cui et al. 2017	176905	173
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Reproduction	NOEC	0.09	Unmeasured	Static	Sperm	0.0007	Xia and Niu 2017	177144	834
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.01	Unmeasured	Renewal	Fry	70	Du et al. 2009	116895	865
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.010	Unmeasured	Static	Embryo	4.9	Jantzen et al. 2016	175223	207
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Reproduction	NOEC	0.005	Unmeasured	Renewal	Embryo	152	Wang et al. 2011	164068	164
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.12	Measured	Renewal	Embryo	14	Du et al. 2016	177092	883
Cyprinidae	*Danio*	Zebra danio	*Danio rerio*	Growth	NOEC	0.00073	Measured	Flow-through	Embryo	316	Keiter et al. 2012	160092	796
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Mortality	NOEC	5.3	Unmeasured	Renewal	Neonate	21	Boudreau et al. 2003	71875	619

Table D.3.2-1 PFOS Freshwater NOEC Values

Family	Genus	Common Name	Scientific Name	Effect	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Population	NOEC	4	Unmeasured	Renewal	Neonate	21	Liang et al. 2017	177138	637
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Reproduction	NOEC	7.4	Reported	Renewal	Not reported	21	Yang et al. 2014	175260	587
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Population	NOEC	30	Unmeasured	Static	Not reported	28	Sanderson et al. 2002	64956	640
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Reproduction	NOEC	11.5	Measured	Renewal	Neonate	21	Drottar and Krueger 2000	175367	590
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Reproduction	NOEC	0.008	Unmeasured	Renewal	Neonate	21	Lu et al. 2015	177104	1349
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Reproduction	NOEC	1.25	Unmeasured	Renewal	Neonate	21	Ji et al. 2008	114976	29
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Reproduction	NOEC	1	Unmeasured	Renewal	Juvenile	21	Li 2010 2010	152183	595
Daphniidae	*Daphnia*	Water flea	*Daphnia magna*	Reproduction	NOEC	0.01	Unmeasured	Renewal	Neonate	25	Jeong et al. 2016	177169	591
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Growth	NOEC	8	Unmeasured	in Vitro	Not intact	7	Yuan et al. 2014	175659	1268
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	NOEC	10	Unmeasured	Not reported	Not reported	4	Li 2009	118450	1266
Dugesiidae	*Dugesia*	Planaria	*Dugesia japonica*	Mortality	NOEC	12	Unmeasured	Static	Not reported	4	Li 2008	111070	1586
Coenagrionidae	*Enallagma*	Common blue damselfly	*Enallagma cyathigerum*	Development	NOEC	0.01	Unmeasured	Renewal	Embryo	>300	Bots et al. 2010	151607	1599
Unionidae	*Lampsilis*	Fatmucket clam	*Lampsilis siliquoidea*	Development	NOEC	0.0045	Measured	Renewal	Glochidia	2	Hazelton et al. 2012	160209	258
Ranidae	*Lithobates (Rana)*	Northern leopard frog	*Lithobates pipiens*	Development	NOEC	0.97	Measured	Flow-through	Embryo	Not Reported	Ankley et al. 2004	77666	454
Ranidae	*Lithobates (Rana)*	Northern leopard frog	*Lithobates pipiens*	Development	NOEC	0.01	Reported	Renewal	Tadpole	40	Hoover et al. 2017	176982	1319
Moinidae	*Moina*	Water flea	*Moina macrocopa*	Reproduction	NOEC	0.31	Unmeasured	Renewal	Neonate	7	Ji et al. 2008	114976	21
Atyidae	*Neocaridina*	Cherry shrimp	*Neocaridina denticulata*	Mortality	NOEC	5	Unmeasured	Not reported	Not reported	4	Li 2009	118450	505
Physidae	*Physella*	European physa	*Physella acuta*	Mortality	NOEC	100	Unmeasured	Not reported	Not reported	3	Li 2009	118450	1233
Cyprinidae	*Pimephales*	Fathead minnow	*Pimephales promelas*	Mortality	NOEC	0.28	Measured	Flow-through	Sexually mature	45	Ankley et al. 2005	81515	849
Cyprinidae	*Pimephales*	Fathead minnow	*Pimephales promelas*	Mortality	NOEC	0.3	Measured	Flow-through	Egg	47	Drottar and Krueger 2000	175366	812
Cyprinidae	*Pseudorasbora*	Stone moroco	*Pseudorasbora parva*	Growth	NOEC	5.6	Reported	Renewal	Not reported	30	Yang et al. 2014	175260	682

Table D.3.2-1 PFOS Freshwater NOEC Values

Family	Genus	Common Name	Scientific Name	Effect	Endpoint	Conc (mg/L)	Chemical Analysis	Exposure Type	Life Stage	Observed Duration (days)	Author	ECOTOX Ref No.	Tracking No.
Phylum Rotifera	-	Rotifer	*Rotifera*	Population	NOEC	30	Unmeasured	Static	Not reported	28	Sanderson et al. 2002	64956	1160
Pipidae	*Xenopus*	African clawed frog	*Xenopus laevis*	Development	NOEC	48	Reported	Renewal	Gastrula	4	San-Segundo et al. 2016	175663	437
Poeciliidae	*Xiphophorus*	Green swordtail	*Xiphophorus helleri*	Morphology	NOEC	0.1	Unmeasured	Renewal	Fry	90	Han and Fang 2010	151613	695

Table D.3.2-2 PFOS Mean Species NOECs for Deriving HC5 Value using GLI Equations

Family	Genus	Common Name	Genus Geomean (µg/L)	Rank
Unionidae	*Lampsilis*	Fatmucket clam	4.5	1
Coenagrionidae	*Enallagma*	Common blue damselfly	10.0	2
Chironomidae	*Chironomus*	Midge	21.7	3
Ranidae	*Lithobates (Rana)*	Northern leopard frog	98.5	4
Poeciliidae	*Xiphophorus*	Common carp	100.0	5
Cyprinidae	*Cyprinus*	Green swordtail	100.0	6
Cyprinidae	*Danio*	Zebra danio	253.8	7
Cyprinidae	*Pimephales*	Fathead minnow	290.3	8
Moinidae	*Moina*	Water flea	312.5	9
Brachionidae	*Brachionus*	Rotifer	500.0	10
Daphniidae	*Daphnia*	Water flea	1,206.9	11
Atyidae	*Neocaridina*	Cherry shrimp	5,000.0	12
Cyprinidae	*Pseudorasbora*	Stone moroco	5,570.0	13
Dugesiidae	*Dugesia*	Planaria	9,864.8	14
Phylum Rotifera	-	Rotifer	30,000.0	15
Pipidae	*Xenopus*	African clawed frog	48,000.0	16
Physidae	*Physella*	European physa	100,000.0	17

Table D.3.2-3 PFOS Freshwater NOEC HC5 Using GLI Equations (µg/L)

Number of families	14
HC5 =	**2.92**

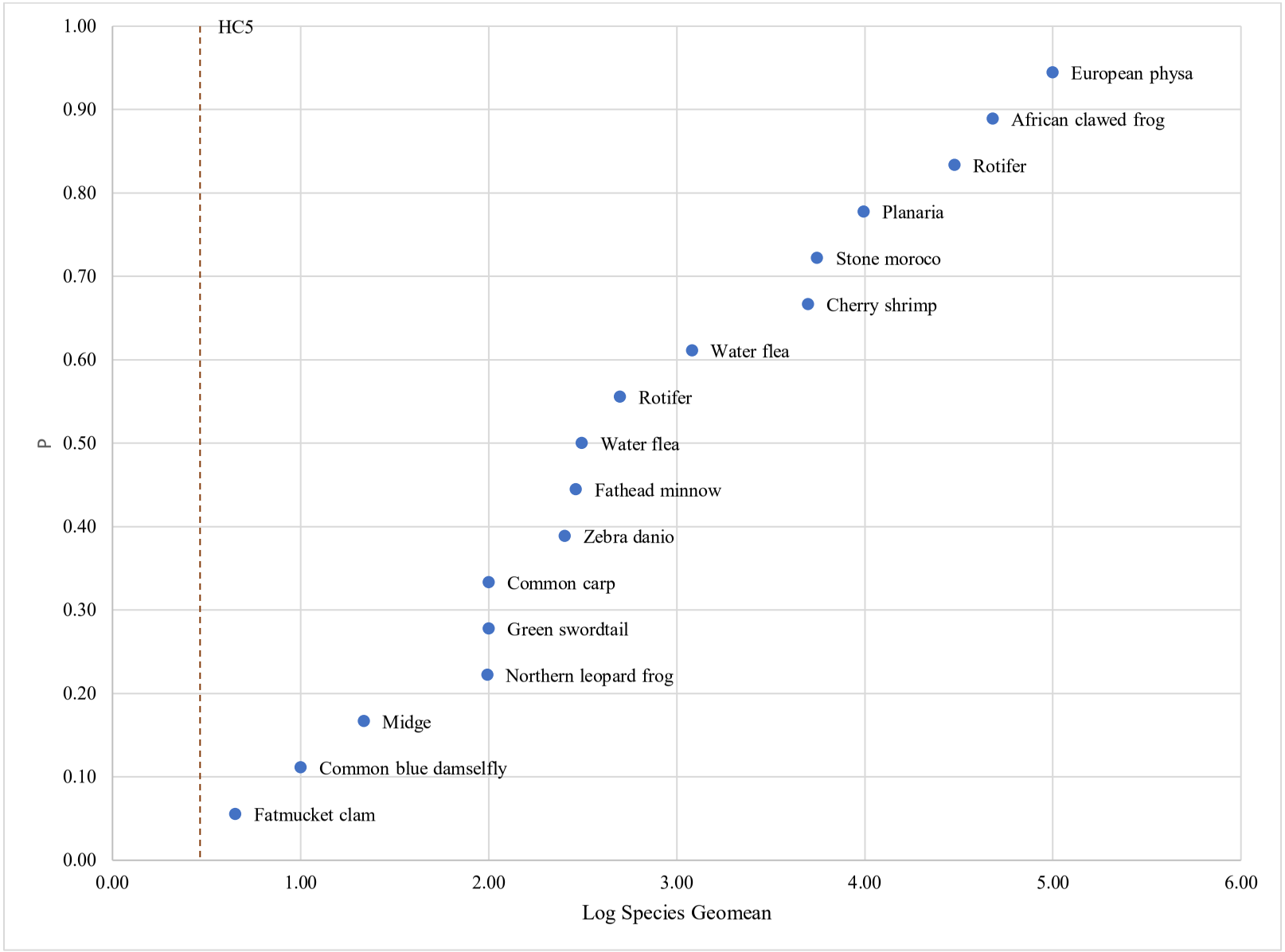

Figure D.3-2 PFOS Freshwater NOEC Species Sensitivity Distribution showing HC5 Derived using GLI Equations

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APPENDIX E: AQUATIC-DEPENDENT WILDLIFE

E.1 EXPOSURE FACTORS FOR AQUATIC-DEPENDENT WILDLIFE

Table E.1-1 Input Exposure Factors Estimating ESVs for Aquatic Wildlife Surrogate Receptors

	Receptor						
Model Parameter	**Belted Kingfisher**	**Herring Gull**	**Osprey**	**Spotted Sandpiper**	**Mallard**	**Mink**	**River Otter**
Bodyweight (kg)	0.15[a]	1.1[a]	1.6[a]	0.042[b]	1.134[b]	0.8[a]	7.4[a]
Diet Composition (%)							
Sediment	0	0	0	0.18[c]	0.03[l]	0	0
Plants	0	0	0	0	0.42[d]	0	0
Invertebrates	0	0	0	0.82[e]	0.56[d]	0	0
Fish TL 3	1.00[a]	0.72[a]	1.00[a]	0	0	0.90[a]	0.80[a]
Fish TL4	0	0.18[a]	0	0	0	0	0.20[a]
Ingestion Rate (kg/d) ww Total	0.0675[a]	0.2805[a]	0.3040[a]	0.0278[f]	0.3308[f]	0.2945[g]	1.7885[h]
Sediment	0	0	0	0.0050[i]	0.0109[i]	0	0
Plants	0	0	0	0	0.1389	0	0
Invertebrates	0	0	0	0.0228	0.1853	0	0
Fish TL 3	0.0675	0.2020	0.3040	0	0	0.2651	1.4308
Fish TL4	0	0.0505	0	0	0	0	0.3577
Water Ingestion Rate (L/d)	0.017[a]	0.063[j]	0.083[j]	0.007[k]	0.054[k]	0.083[j]	0.599[j]

[a] GLWQI Technical Support Document for Wildlife Criteria, EPA (1995a).
[b] Average of adult male and female weights from Wildlife Exposure Handbook, EPA (1993).
[c] Based on average (18%) sediment diet contribution for semipalmated, western, stilt, and least sandpipers in EPA (1993).
[d] Average of male and female values from EPA (1993).
[e] Assumes diet is only invertebrates minus the 18% sediment component (EPA 1993).
[f] Derived using allometric equation; $Fi = 0.301W^{0.751}$ (EPA 1993).
[g] Average of small and large mink food ingestion rates from EPA (2009).
[h] Average of range from EPA (2009); 1.032–2.545.
[i] Calculated as the product of the corresponding diet percentage and the total food ingestion rate.
[j] Derived using water ingestion rate (g/g-day) from EPA (1993) and bodyweight from EPA (1995b), and converted to L/day.
[k] Derived from average of male and female rates in EPA (1993), converted from g/g-day to L/day.
[l] EPA (1993).

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E.2 BIOACCUMULATION FACTORS (BAFs), BIOCONCENTRATION FACTORS (BCFs), AND BIOMAGNIFICATION FACTORS (BMFs) FOR ESTIMATING EXPOSURE TO AQUATIC WILDLIFE

Table E.2-1 Input Values for Estimating Food Chain Exposure of Aquatic Wildlife

PFAS	BSAF (Benthic Invertebrates)	BAF Pelagic Invertebrates (L/kg ww)	BCF Fish (L/kg ww)	BMF Fish	Aquatic Plant BCF (L/kg)
Carboxylic Acids					
PFBA	dg[a]	dg	1.7[b]	0.007[c]	dg
PFHxA	0.10[d]	2.10[e]	4.1[b]	0.019[c]	25[f]
PFOA	0.95[g]	91[h]	4[i]	0.039[j]	28[f]
PFNA	1.60[g]	152[h]	39[i]	0.23[k]	58[f]
PFDA	1.02[g]	175[h]	450[i]	0.23[c]	110[f]
Sulfonic Acids					
PFBS	0.31[d]	0.0065[l]	3.3[b]	0.02[k]	19[f]
PFHxS	2.10[d]	236[e]	9.6[i]	0.16[m]	28[f]
PFOS	1.22[g]	179[h]	1100[i]	0.37[n]	90[f]

[a] dg = data gap.
[b] Wen et al. (2017). Lab study and muscle tissue. Geomean of BCFs for liver, blood, intestine, gill, ovary, brain, and muscle.
[c] Martin et al. (2003a). Lab-derived estimate (fish carcass) with trout and spiked food.
[d] Lasier et al. (2011). Lab raised and exposed *Lumbriculus* to and field collected sediments.
[e] Larson et al. (2018), using KOC values from Higgins and Luthy (2006) and Guelfo and Higgins (2013).
[f] Pi et al. (2017).
[g] Higgins et al. (2007). Lab-derived estimate with *L. variegatus* and spiked sediment.
[h] Dai et al. (2013). *Daphnia* and spiked water.
[I] Martin et al. (2003b). Lab-derived estimate with trout (fish carcass) and spiked water.
[j] Geometric mean of Martin et al. (2003a; 0.038) and Goeritz et al. (2013; 0.04).
[k] Chen et al. (2018).
[l] Goeritz et al. (2013), using lab-exposed rainbow trout.
[m] Geometric mean of Martin et al. (2003a; 0.14) and Goeritz et al. (2013; 0.18).
[n] Geometric mean of Martin et al. (2003b; 0.32) and Goeritz et al. (2013; 0.42).

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E.3 TEST DOSE (TD) VALUES USED FOR DEVELOPING AQUATIC WILDLIFE ESVS

Table E.3-1 Test Dose (mg/kg BW/day; either a NOAEL or LOAEL)

PFAS	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
Carboxylic Acids							
PFBA	dg[a]	dg	dg	dg	dg	35[b]	35[b]
PFHxA	dg	dg	dg	dg	dg	100[c]	100[c]
PFOA	dg	dg	dg	dg	dg	1.75[d]	1.75[d]
PFNA	dg	dg	dg	dg	dg	0.83[e]	0.83[e]
PFDA	dg	dg	dg	dg	dg	3.0[f]	3.0[f]
Sulfonic Acids							
PFBS	3,160[g]	3,160[g]	3,160[g]	3,160[g]	3,160[g]	60[h]	60[h]
PFHxS	dg	dg	dg	dg	dg	1.0[i]	1.0[i]
PFOS	1.5[j]	1.5[j]	1.5[j]	1.5[j]	1.5[j]	0.0327[k]	0.0327[k]

[a] dg = data gap.
[b] Das et al. (2008). NOAEL for multiple reproductive and growth endpoints.
[c] Iwai and Hoberman (2014). NOAEL for mice pup development (bodyweight).
[d] DeWitt et al. (2008). Benchmark dose low (BMD-low) value for immunomodulation effects in female mice as derived by Johnson et al. (2021) citing this study.
[e] Wolf et al. (2010). No significant difference in reproduction. Next highest dose (1.1 mg/kg-day) resulted in 46% reduction in live births.
[f] Harris and Birnbaum (1989). LOEL reduced fetal bodyweight by 6%, not considered adverse. Next highest dose had 23% reduction (LOAEL).
[g] Newsted et al. (2008). LOAEL of 3,160 mg/kg-day for growth (bodyweight) in bobwhite in acute exposures.
[h] Leider et al. (2009). PFBS NOAEL of 60 mg/kg-day for hematological effects in mice in sub-chronic (90-day) exposures converted to a TRV of 5.3 mg/kg-day by Johnson et al. (2021), citing this study after adjusting for the molecular weight of potassium in the salt form used in the study ($60 \times 0.8 = 53$).
[i] Chang et al. (2018). LOEL with <20% reduction in litter size compared to controls.
[j] Newsted et al. (2007); Gallagher et al. (2003a,b). NOAEL for reproductive effects in bobwhite in chronic exposures as identified by Johnson et al. (2021) citing these studies.
[k] Thomford (2002). Benchmark dose low (BMD-low) value for histopathological effects in male rats in chronic exposures as derived by Johnson et al. (2021) citing this study.

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E.4 UNCERTAINTY FACTORS

Development of aquatic wildlife ESVs following the Great Lakes Water Quality Initiative guidance (EPA 1995) includes use of uncertainty factors for extrapolating across taxa, exposure durations, and endpoints. For each extrapolation category, uncertainty factors may range from 1 (no extrapolation required) to 10 (greatest extrapolation).

Table E.4-1 Uncertainty Factors for Inter-taxon Extrapolation (UF_A), Extrapolation Across Exposure Durations (UF_S), and Extrapolating across Endpoints (UF_L) Used in Developing Aquatic ESVs for Protection of Wildlife

PFAS		Belted Kingfisher (Aves Coraciformes Alcedinidae)	Herring Gull (Aves Charadriformes Laridae)	Osprey (Aves Accipotriformes Pandionidae)	Spotted Sandpiper (Aves Charadriformes Scolopacidae)	Mallard (Aves Anseriformes Anatidae)	Mink (Mammalia Carnivora Mustelidae)	River Otter (Mammalia Carnivora Mustelidae)
Carboxylic Acids								
PFBA								
	UF_A	dg	dg	dg	dg	dg	8[a]	8[a]
	UF_S	dg	dg	dg	dg	dg	1[b]	1[b]
	UF_L	dg	dg	dg	dg	dg	1[c]	1[c]
PFHxA								
	UF_A	dg	dg	dg	dg	dg	8[d]	8[d]
	UF_S	dg	dg	dg	dg	dg	5[e]	5[e]
	UF_L	dg	dg	dg	dg	dg	1[f]	1[f]
PFOA								
	UF_A	dg	dg	dg	dg	dg	1[g]	1[g]
	UF_S	dg	dg	dg	dg	dg	1[h]	1[h]
	UF_L	dg	dg	dg	dg	dg	1[i]	1[i]
PFNA								
	UF_A	dg	dg	dg	dg	dg	8[j]	8[j]
	UF_S	dg	dg	dg	dg	dg	5[k]	5[k]
	UFl	dg	dg	dg	dg	dg	1[l]	1[l]
PFDA								
	UF_A	dg	dg	dg	dg	dg	8[m]	8[m]
	UFs	dg	dg	dg	dg	dg	5[n]	5[n]
	UF_L	dg	dg	dg	dg	dg	1[o]	1[o]
Sulfonic Acids								
PFBS								
	UF_A	1[p]	1[p]	1[p]	1[p]	1[p]	3.33[s]	3.33[s]
	UF_S	6[q]	6[q]	6[q]	6[q]	6[q]	3[t]	3[t]
	UF_L	5[r]	5[r]	5[r]	5[r]	5[r]	1[u]	1[u]

Table E.4-1 Uncertainty Factors for Inter-taxon Extrapolation (UF_A), Extrapolation Across Exposure Durations (UF_S), and Extrapolating across Endpoints (UF_L) Used in Developing Aquatic ESVs for Protection of Wildlife

PFAS		Belted Kingfisher (Aves Coraciformes Alcedinidae)	Herring Gull (Aves Charadriformes Laridae)	Osprey (Aves Accipotriformes Pandionidae)	Spotted Sandpiper (Aves Charadriformes Scolopacidae)	Mallard (Aves Anseriformes Anatidae)	Mink (Mammalia Carnivora Mustelidae)	River Otter (Mammalia Carnivora Mustelidae)
PFHxS								
	UF_A	dg	dg	dg	dg	dg	8[v]	8[v]
	UF_S	dg	dg	dg	dg	dg	3[w]	3[w]
	UF_L	dg	dg	dg	dg	dg	3[x]	3[x]
PFOS								
	UF_A	10[y]	10[y]	10[y]	10[y]	10[y]	1[bb]	1[bb]
	UF_S	1[z]	1[z]	1[z]	1[z]	1[q]	1[cc]	1[cc]
	UF_L	1[aa]	1[aa]	1[aa]	1[aa]	1[aa]	1[dd]	1[dd]

[a] Das et al. (2008). Mouse study: different species, genus, family, and order.
[b] Das et al. (2008). Chronic study, 294-day duration. Sub-chronic. Only dosed for 90 days; a small fraction of life cycle.
[c] Das et al. (2008). NOAEL for multiple reproductive and growth endpoints.
[d] Iwai and Hoberman (2014). Mouse study: different species, genus, family, and order.
[e] Iwai and Hoberman (2014). Sub-chronic study; 18 days.
[f] Iwai and Hoberman (2014). Mouse study; NOAEL, no effect level for pup growth.
[g] DeWitt et al. (2008). Mouse study cited by Johnson et al. (2021) in deriving the TRV for class Mammalia.
[h] DeWitt et al. (2008). Sub-chronic (15-day) exposures.
[I] DeWitt et al. (2008). Benchmark dose-low for immunomodulation effects in female mice.
[j] Wolf et al. (2010). Mouse study; different species, genus, family, and order.
[k] Wolf et al. (2010). Sub-chronic tests with 18-day exposure period during critical post-gestational days of 1–18.
[l] Wolf et al. (2010). NOAEL. No significant difference in reproduction. Next highest dose 1.1 mg/kg/day resulted in 46% reduction in live pup births.
[m] Harris and Birnbaum (1989, as cited in Conder et al. 2019). Mouse study. Different species, genus, family, and order.
[n] Harris and Birnbaum (1989). Sub-chronic, 18-day. Reproduction, development.
[o] Harris and Birnbaum (1989). NOAEL reduced fetal bodyweight by 6%, not considered adverse. Next highest dose had 23% reduction (LOAEL).
[p] Newsted et al. (2008). Bobwhite in acute exposures study cited by Johnson et al. (2021) in deriving an Avian TRV applying a total UF = 30.
[q] Newsted et al. (2008). Acute exposure.
[r] Newsted et al. (2008). LOAEL for growth (bodyweight).
[s] Leider et al. (2009). Mouse study cited by Johnson et al. (2021) in deriving TRV for class Mammalia.
[t] Leider et al. (2009). Sub-chronic (90-day) exposures.
[u] Leider et al. (2009). NOAEL for hematological effects.
[v] Chang et al., 2018. Mouse study; different species, genus, family, and order.
[w] Chang et al. (2018). Sub-chronic. All life stages exposed; 77-day duration.
[x] Chang et al. (2018). LOEL with <14% decrease in litter size.
[y] Newsted et al. (2007); Gallagher et al. (2003a,b). Bobwhite quail studies cited by Johnson et al. (2021) in deriving avian TRV applying a UF =10.
[z] Newsted et al. (2007); Gallagher et al. (2003a,b). Chronic study.

Table E.4-1 Uncertainty Factors for Inter-taxon Extrapolation (UF_A), Extrapolation Across Exposure Durations (UF_S), and Extrapolating across Endpoints (UF_L) Used in Developing Aquatic ESVs for Protection of Wildlife

PFAS	Belted Kingfisher (Aves Coraciformes Alcedinidae)	Herring Gull (Aves Charadriformes Laridae)	Osprey (Aves Accipotriformes Pandionidae)	Spotted Sandpiper (Aves Charadriformes Scolopacidae)	Mallard (Aves Anseriformes Anatidae)	Mink (Mammalia Carnivora Mustelidae)	River Otter (Mammalia Carnivora Mustelidae)

[aa] Newsted et al. (2007); Gallagher et al. (2003a,b). NOAEL for reproductive effects.
[bb] Thomford (2002). Rat study cited by Johnson et al. (2021) in deriving the TRV for class Mammalia.
[cc] Thomford (2002). Chronic study.
[dd] Thomford (2002). Benchmark dose-low for histopathological effects.

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E.5 DERIVATION OF SURFACE WATER ESVS FOR AQUATIC-DEPENDENT WILDLIFE

Table E.5-1 Derivation of PFOS Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFOS TD mg/kg-d; NOAEL or LOAEL	1.5	1.5	1.5	1.5	1.5	0.0327	0.0327
Wt kg; average weight in kg	0.15	1.1	1.6	0.04	1.13	0.8	7.4
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.29	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.56	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.42	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed in kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	1.22	1.22	1.22	1.22	1.22	1.22	1.22
Food trophic level 1 and 2; pelagic inverts BAF L/kg	179	179	179	179	179	179	179
Food trophic level; plants BCF L/kg	90.0	90.0	90.0	90.0	90.0	90.0	90.0
Food fish trophic level 3; BCF L/kg	1100	1100	1100	1100	1100	1100	1100
Food fish trophic level 4; BCF L/kg	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Uncertainty factor UF_a (across species)	10	10	10	10	10	1	1
Uncertainty factor UF_s (sub-chronic to chronic)	1	1	1	1	1	1	1
Uncertainty factor UF_l (LOAEL to NOAEL)	1	1	1	1	1	1	1
Total UF ($UF_a \times UF_s \times UF_l$)	10	10	10	10	10	1	1
TD/Total UF (=mg/kg-day)	0.15	0.15	0.15	0.15	0.15	0.0327	0.037
(TD/Total UF) × Wt (=mg/day)	0.023	0.165	0.240	0.0063	0.17	0.026	0.24
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	74.3	222	334	0.00	0.00	291	1574

Table E.5-1 Derivation of PFOS Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.02	0.00	0.00	0.00	0.00	0.13
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.03	0.68	0.00	0.00
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BCF; kg/day	0.00	0.00	0.00	0.00	37.8	0.00	0.00
Total: L/day	74.2	222	334	0.03	38.5	291	1574
Total daily food ingestion + water daily ingestion L/day	74.3	222	334	0.040	38.6	292	1575
Receptor-specific wildlife value ug PFOS/L (WV)	0.030	0.74	0.72	160	4.4	0.090	0.15
Final aquatic avian wildlife value µg/L	2.57[a]		0.54[b]	26.4[c]			
Final Aquatic Mammal Wildlife Value ug/L	0.117[d]		0.117	0.117			
Final Wildlife Value ug/L	**0.117[e]**		**0.117[e]**	**0.117[e]**			

[a] Geometric mean of all five avian receptor WVs.
[b] Geometric mean only of belted kingfisher, herring gull, and osprey WVs.
[c] Geometric mean only of spotted sandpiper and mallard WVs.
[d] Geometric mean of mink and river otter WVs.
[d] Lowest of final avian and mammal WVs.

Table E.5-2 Derivation of PFHxS Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFHxS TD mg/kg-day; NOAEL or LOAEL	na[a]	na	na	na	na	1.00	1.00
Wt kg; average weight in kg	0.15	1.10	1.60	0.04	1.13	0.8	7.4
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.30	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.56	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.42	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Food trophic level 1 and 2; pelagic inverts BAF L/kg	236	236	236	236	236	236	236
Food trophic level; plants BCF	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Food fish trophic level 3; BCF L/kg	9.60	9.60	9.60	9.60	9.60	9.60	9.60
Food fish trophic level 4; BCF L/kg	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Uncertainty factor UF_a (across species)	1	1	1	1	1	8	8
Uncertainty factor UF_s (sub-chronic to chronic)	1	1	1	1	1	3	3
Uncertainty factor UF_l (LOAEL to NOAEL)	1	1	1	1	1	3	3
Total UF ($UF_a \times UF_s \times UF_l$)	1	1	1	1	1	72	72
TD/total UF (=mg/kg-day)	0.00	0.00	0.00	0.00	0.00	0.01	0.01
(TD/total UF) × Wt (=mg/dg)	0.00	0.00	0.00	0.00	0.00	0.01	0.10
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	0.65	1.94	2.92	0.00	0.00	2.54	13.7
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.01	0.00	0.00	0.00	0.00	0.06
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.02	0.48	0.00	0.00

Table E.5-2 Derivation of PFHxS Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BCF; kg/day	0.00	0.00	0.00	0.00	11.8	0.0	0.0
Total: L/day	0.65	1.95	2.92	0.03	12.3	2.54	13.8
Total daily food ingestion + water daily ingestion	0.67	2.01	3.00	0.03	12.3	2.63	14.4
Receptor-specific wildlife value µg PFOS/L (WV)	0.00	0.00	0.00	0.00	0.00	4.23	7.14
Final aquatic avian wildlife value µg/L	-						
Final aquatic mammal wildlife value µg/L	5.495[b]						
Final Wildlife Value µg/L	**5.495[c]**						

[a] No dose available.
[b] Geometric mean of mink and river otter WVs.
[c] Lowest of final avian and mammal WVs.

Table E.5-3 Derivation of PFBS Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFBS TD mg/kg-day; NOAEL or LOAEL	3,160	3,160	3,160	3,160	3,160	53	53
Wt kg; average weight in kg	0.15	1.10	1.60	0.04	1.13	0.80	7.40
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.29	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.56	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.42	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Food trophic level 1 and 2; pelagic inverts BAF L/kg	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Food trophic level; plants BCF	19.0	19.0	19.0	19.0	19.0	19.0	19.0
Food fish trophic level 3; BCF L/kg	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Food fish trophic level 4; BCF L/kg	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uncertainty factor UF_a (across species)	1	1	1	1	1	3.33	3.33
Uncertainty factor UF_s (sub-chronic to chronic)	6	6	6	6	6	3	3
Uncertainty factor UF_l (LOAEL to NOAEL)	5	5	5	5	5	1	1
Total UF ($UF_a \times UF_s \times UF_l$)	30	30	30	30	30	10	10
TD/total UF (=mg/kg-day)	105	105	105	105	105	5.30	5.30
(TD/total UF) × Wt (=m/dg)	15.8	116	169	4.42	119	4.24	39.2

Table E.5-3 Derivation of PFBS Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	0.22	0.67	1.00	0.00	0.00	0.87	4.72
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.01
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.01	0.17	0.00	0.00
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BCF; kg/day	0.00	0.00	0.00	0.00	7.98	0.00	0.00
Total: L/day	0.22	0.67	1.00	0.01	8.19	0.87	4.73
Total daily food ingestion + water daily ingestion	0.24	0.73	1.09	0.02	8.24	0.96	5.33
Receptor specific wildlife value µg PFOS/L (WV)	65,902	158,618	155,159	231,781	14,495	4,428	7,362
Final aquatic avian wildlife value µg/L	88,565[a]		117,492[b]	57,963[c]			
Final aquatic mammal wildlife value µg/L	5,710[d]		5,710	5,710			
Final aquatic wildlife value µg/L	**5,710[e]**		**5,710[e]**	**5,710[e]**			

[a] Geometric mean of all five avian receptor WVs.
[b] Geometric mean only of belted kingfisher, herring gull, and osprey WVs.
[c] Geometric mean only of spotted sandpiper and mallard WVs.
[d] Geometric mean of mink and river otter WVs.
[d] Lowest of final avian and mammal WVs.

Table E.5-4 Derivation of PFDA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFDA TD mg/kg-day; NOAEL or LOAEL	na[a]	na	na	na	na	3.00	3.00
Wt kg; average weight in kg	0.15	1.10	1.60	0.04	1.13	0.80	7.40
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.29	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.56	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.42	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Food trophic level 1 and 2; pelagic inverts BAF L/kg	175	175	175	175	175	175	175
Food trophic level; plants BCF	110	110	110	110	110	110	110
Food fish trophic level 3; L/kg	450	450	450	450	450	450	450
Food fish trophic level 4; BCF L/kg	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Uncertainty factor UF_a (across species)	1.00	1.00	1.00	1.00	1.00	8.00	8.00
Uncertainty factor UF_s (sub-chronic to chronic)	1.00	1.00	1.00	1.00	1.00	5.00	5.00
Uncertainty factor UF_l (LOAEL to NOAEL)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total UF ($UF_a \times UF_s \times UF_l$)	1.00	1.00	1.00	1.00	1.00	40.0	40.0
TD/total UF (=mg/kg-day)	0.00	0.00	0.00	0.00	0.00	0.08	0.08
(TD/total UF) × Wt (=mg/day)	0.00	0.00	0.00	0.00	0.00	0.06	0.56
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	30.4	90.9	137	0.00	0.00	119	644
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.01	0.00	0.00	0.00	0.00	0.08
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.02	0.57	0.00	0.00

Table E.5-4 Derivation of PFDA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BCF; kg/day	0.00	0.00	0.00	0.00	46.20	0.00	0.00
Total: L/day	30.4	90.9	137	0.02	46.8	119	649
Total daily food ingestion + water daily ingestion	30.39	91.0	137	0.03	46.8	119	644
Receptor-specific wildlife value µg PFOS/L (WV)	0.00	0.00	0.00	0.00	0.00	0.50	0.86
Final aquatic avian wildlife value µg/L	-						
Final aquatic mammal wildlife value µg/L	0.66[b]						
Final Wildlife Value µg/L	**0.66[c]**						

[a] No dose available.
[b] Geometric mean of mink and river otter WVs.
[c] Lowest of final avian and mammal WVs.

Table E.5-5 Derivation of PFNA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFNA TD mg/kg-day; NOAEL or LOAEL	na[a]	na	na	na	na	0.83	0.83
Wt kg; average weight in kg	0.15	1.1	1.6	0.04	1.13	0.8	7.4
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.30	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.56	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.42	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Food trophic level 1 and 2; pelagic inverts BAF L/kg	152	152	152	152	152	152	152
Food trophic level; plants BCF	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Food fish trophic level 3; L/kg	39.0	39.0	39.0	39.0	39.0	39.0	39.0
Food fish trophic level 4; BCF L/kg	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Uncertainty factor UF_a (across species)	1	1	1	1	1	8	8
Uncertainty factor UF_s (sub-chronic to chronic)	1	1	1	1	1	5	5
Uncertainty factor UF_l (LOAEL to NOAEL)	1	1	1	1	1	1	1
Total UF ($UF_a \times UF_s \times UF_l$)	1.00	1.00	1.00	1.00	1.00	40.0	40.0
TD/total UF (mg/kg-day)	0.00	0.00	0.00	0.00	0.00	0.02	0.02
(TD/total UF) × Wt (mg)	0.00	0.00	0.00	0.00	0.00	0.02	0.15
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.005	0.033	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	2.63	7.88	11.9	0.00	0.00	10.3	55.8
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.01	0.00	0.00	0.00	0.00	0.08
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.04	0.90	0.00	0.00

Table E.5-5 Derivation of PFNA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/D] × BCF; kg/day	0.00	0.00	0.00	0.00	24.4	0.00	0.00
Total: L/day	2.63	7.89	11.9	0.04	25.3	10.3	55.9
Total daily food ingestion + water daily ingestion	2.65	7.95	11.9	0.05	25.3	10.4	56.5
Receptor-specific wildlife value µg PFOS/L (WV)	0.00	0.00	0.00	0.00	0.00	1.59	2.72
Final aquatic avian wildlife value µg/L	-						
Final aquatic mammal wildlife value µg/L	2.08[b]						
Final Wildlife Value µg/L	**2.08[c]**						

[a] No dose available.
[b] Geometric mean of mink and river otter WVs.
[c] Lowest of final avian and mammal WVs.

Table E.5-6 Derivation of PFOA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFOA TD mg/kg-day; NOAEL or LOAEL	na[a]	na	na	na	na	1.75	1.75
Wt kg; average weight in kg	0.15	1.10	1.60	0.04	1.13	0.80	7.40
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.29	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.56	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.42	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Food trophic level 1 and 2; pelagic inverts BAF L/kg	91.0	91.0	91.0	91.0	91.0	91.0	91.0
Food trophic level; plants BCF	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Food fish trophic level 3; L/kg	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Food fish trophic level 4; BCF L/kg	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Uncertainty factor UF_a (across species)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uncertainty factor UF_s (sub-chronic to chronic)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uncertainty factor UF_l (LOAEL to NOAEL)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total UF ($UF_a \times UF_s \times UF_l$)	1.00	1.00	1.00	1.00	1.00	1.0	1.0
TD/total UF (=mg/kg-day)	0.00	0.00	0.00	0.00	0.00	1.75	1.75
(TD/total UF) × Wt (=mg/day)	0.00	0.00	0.00	0.00	0.00	1.40	12.95
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	0.27	0.81	1.22	0.00	0.00	1.06	5.72
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.01
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.02	0.53	0.00	0.00

Table E.5-6 Derivation of PFOA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BCF; kg/day	0.00	0.00	0.00	0.00	11.76	0.00	0.00
Total: L/day	0.27	0.81	1.22	0.03	12.33	1.06	5.74
total daily food ingestion + water daily ingestion	0.29	0.87	1.30	0.03	12.38	1.14	6.34
Receptor-specific wildlife value µg PFOS/L (WV)	0.00	0.00	0.00	0.00	0.00	1,225	2,044
Final aquatic avian wildlife value µg/L	-		-	-			
Final aquatic mammal wildlife value µg/L	1,580[b]						
Final wildlife value µg/L	**1,580[c]**						

[a] No dose available.
[b] Geometric mean of mink and river otter WVs.
[c] Lowest of final avian and mammal WVs.

Table E.5-7 Derivation of PFHxA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFHxA TD mg/kg-day; NOAEL or LOAEL	na[a]	na	na	na	na	100	100
Wt kg; average weight in kg	0.15	1.10	1.60	0.04	1.13	0.80	7.40
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.29	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.19	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Food trophic level 1 and 2; pelagic inverts BAF L/kg	2.10	2.10	2.10	2.10	2.10	2.10	2.10
Food trophic level; plants BCF	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Food fish trophic level 3; L/kg	4.10	4.10	4.10	4.10	4.10	4.10	4.10
Food fish trophic level 4; BCF L/kg	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uncertainty factor UF_a (across species)	1.00	1.00	1.00	1.00	1.00	8.00	8.00
Uncertainty factor UF_s (sub-chronic to chronic)	1.00	1.00	1.00	1.00	1.00	4.00	5.00
Uncertainty factor UF_l (LOAEL to NOAEL)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total UF ($UF_a \times UF_s \times UF_l$)	1.00	1.00	1.00	1.00	1.00	40.00	40.00
TD/total UF (=mg/kg-day)	0.00	0.00	0.00	0.00	0.00	2.50	2.50
(TD/total UF) × Wt (=mg/day)	0.00	0.00	0.00	0.00	0.00	2.00	18.50
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.01	0.01	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	0.28	0.83	1.25	0.00	0.00	1.09	5.87
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.01
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.00	0.02	0.00	0.00

Table E.5-7 Derivation of PFHxA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BCF; kg/day	0.00	0.00	0.00	0.00	3.47	0.00	0.00
Total: L/day	0.28	0.83	1.25	0.01	3.50	1.09	5.87
Total daily food ingestion + water daily ingestion	0.29	0.89	1.33	0.01	3.56	1.17	6.47
Receptor-specific wildlife value µg PFOS/L (WV)	0.00	0.00	0.00	0.00	0.00	1,710	2,860
Final aquatic avian wildlife value µg/L	-						
Final aquatic mammal wildlife value µg/L	2,210[b]						
Final wildlife value µg/L	**2,210[c]**						

[a] No dose available.
[b] Geometric mean of mink and river otter WVs.
[c] Lowest of final avian and mammal WVs.

Table E.5-8 Derivation of PFBA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
PFBA TD mg/kg-day; NOAEL or LOAEL	na[a]	na	na	na	na	35.0	35.0
Wt kg; average weight in kg	0.15	1.10	1.60	0.04	1.13	0.80	7.40
W: Water ingestion; average daily water consumptions L/day	0.02	0.06	0.08	0.01	0.05	0.08	0.60
Total daily food ingestion rate kg/day	0.07	0.28	0.30	0.03	0.33	0.29	1.79
Food ingestion rate of sediment; average consumed in kg/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
Food ingestion rate of benthic inverts; average consumed in kg/day	0.00	0.00	0.00	0.02	0.19	0.00	0.00
Food ingestion rate of pelagic inverts; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food ingestion rate of plants; average consumed in kg/day	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Food ingestion rate of trophic level 3 fish; average consumed kg/day	0.07	0.20	0.30	0.00	0.00	0.27	1.43
Food ingestion rate of trophic level 4 fish; average consumed in kg/day	0.00	0.05	0.00	0.00	0.00	0.00	0.36
Food ingestion rate of birds; average consumed in kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; benthic inverts BAF (g OC/g ww; unitless)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level 1 and 2; pelagic inverts BAF L/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food trophic level; plants BCF	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Food fish trophic level 3; L/kg	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Food fish trophic level 4; BCF L/kg	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Uncertainty factor UF_a (across species)	1.00	1.00	1.00	1.00	1.00	8.00	8.00
Uncertainty factor UF_s (sub-chronic to chronic)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uncertainty factor UF_l (LOAEL to NOAEL)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total UF ($UF_a \times UF_s \times UF_l$)	1.00	1.00	1.00	1.00	1.00	8.00	8.00
TD/total UF (=mg/kg-day)	0.00	0.00	0.00	0.00	0.00	4.38	4.38
(TD/total UF) × Wt (=mg/day)	0.00	0.00	0.00	0.00	0.00	3.50	32.4
(Daily ingestion sediment [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.01	0.03	0.00	0.00
(Daily ingestion trophic level 3 fish [kg/day]) × (BCF [L/kg]); L/day	0.11	0.34	0.52	0.00	0.00	0.45	2.43
(Daily ingestion trophic level 4 fish [kg/day]) × (BCF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(Daily ingestion benthic inverts [kg/day]) × BAF; kg/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(Daily ingestion pelagic inverts [kg/day]) × (BAF [L/kg]); L/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily ingestion plants [kg/day] × BAF; kg/day	0.00	0.00	0.00	0.00	0.14	0.00	0.00

Table E.5-8 Derivation of PFBA Aquatic Wildlife ESV

	Belted Kingfisher	Herring Gull	Osprey	Spotted Sandpiper	Mallard	Mink	River Otter
Total daily ingestion × BAF: L/day	0.11	0.34	0.52	0.01	0.17	0.45	2.43
Total daily food ingestion + water daily ingestion	0.13	0.41	0.60	0.01	0.23	0.53	3.03
Receptor-specific wildlife value µg PFOS/L (WV)	0.00	0.00	0.00	0.00	0.00	6,559	10,672
Final aquatic avian wildlife value µg/L	-						
Final aquatic mammal wildlife value µg/L	8,367[b]						
Final wildlife value µg/L	**8,367[c]**						

[a] No dose available.
[b] Geometric mean of mink and river otter WVs.
[c] Lowest of final avian and mammal WVs.

APPENDIX F: LITERATURE REVIEW

CONTENTS

TABLE F-1 STUDIES ACCEPTED FOR ECOLOGICAL SCREENING LEVEL DEVELOPMENT

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Amraoui et al. 2018	Mollusk	*Unio ravoisieri*		X							Acute 4 days	177085
Ankley et al. 2005	Fish	*Pimephales promelas*		X							Chronic	81515
Ankley et al. 2004	Amphibian	*Rana pipiens*		X							Chronic	77666
Annunzio et al	Fish	*Danio rerio*						X	X		Acute	178562
Barmentlo et al. 2015	Crustacean	*Daphnia magna*	X		X			X			Acute and chronic	175699
Bots et al. 2010	Insect	*Enallagma cyathigerum*.		X							Acute and chronic	151607
Boudreau 2002	Crustacean and plant	*Daphnia magna and lemma gibba*	X		X		X			X	Acute	175259
Boudreau, Wilson et al. 2003a	Rotifers, crustaceans, algae and plant	92 species of Rotifera, Cladocera, Copepoda, macroinvertebrates, and Ostracoda and *Lemna gibba*		X							Chronic	71735
Boudreau et al. 2003b	Algae, plants, crustaceans	*Selenastrum capricornutum, Chlorella vulgaris, Lemna gibba, Daphnia magna*, and *Daphnia pulicaria*		X							Acute and chronic	71875
Chen et al. 2014	Fish	*Danio rerio*		X							Acute 4 days	168368
Colombo et al. 2008	Algae, crustacean, fish	*Pseudokirchneriella subcapitata, Daphnia magna, Oncorhynchus mykiss,*	X								Acute and chronic	151611
Corrales et al. 2017	Fish	*Pimephales promelas and Danio rerio*	X								Acute	177136

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Cui et al. 2017	Fish	*Danio rerio*		X							Chronic	176905
Dang et al. 2018	Fish	*Danio rerio*		X							Acute 4 days	178026
Ding et al. 2012a	Crustacean	*Daphnia magna* and *Chydorus sphaericus*	X		X		X			X	Acute	160946
Ding et al. 2012b	Algae	*Pseudokirchneriella subcapitata*	X		X		X			X	Acute	160551
Ding et al. 2013	Fish	*Danio rerio*	X	X							Acute 4 days	175221
Drottar and Krueger 2000	Fish	*Pimephales promelas*		X							Acute and chronic	175366
Drottar and Krueger 2000	Marine mollusc	*Crassostrea virginica*		X							Acute 4 days	175360
Drottar and Krueger 2000	Marine crustacean	*Mysidopsis bahia*		X							Acute 96 hr	175364
Drottar and Krueger 2000	Marine Crustacean	*Mysidopsis bahia*		X							Chronic 35 days	175363
Drottar and Krueger 2000a	Crustacean	*Daphnia magna*		X							Acute 48 hr	175365
Drottar and Krueger 2000b	Crustacean	*Daphnia magna*		X							Chronic 21 days	175367
Drottar and Krueger 2000	Algae	*Selenastrum capricornutum*		X							Acute	175368
Drottar and Krueger 2000	Mollusc	*Unio complamatus*		X							Acute 4 days	175369
Drottar et al. 2001	Fish	*Lepomis macrochirus*		X							Chronic	175359
Du et al. 2009	Fish	*Danio rerio*		X							Chronic	116895
Du et al. 2016a	Fish	*Danio rerio*		X							Acute	177092
Du et al. 2016b	Fish	*Danio rerio*		X							Acute	177124
DuPont Co. 1994	Fish	*Lepomis macrochirus*	X								Acute	151364
DuPont Co. 1994	Fish	*Oncorhynchus mykiss*	X								Acute	151364
Fabbri et al. 2014	Marine mollusc	*Mytilus galloprovincialis*	X	X							Acute	169855
Fang et al. 2012	Marine fish	*Oryzias melastigma*		X							Chronic	160550

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Godfrey et al. 2017	Fish	*Danio rerio*	X		X						Acute	177139
Gonzalez-Naranjo and Boltes 2014	Algae	*Pseudokirchneriella subcapitata,*	X								Chronic	176911
Gunduz et al. 2013	Echinoderm	*Paracentrotus lividus*		X							Chronic	176044
Hagenaars et al. 2008	Fish	*Cyprinus carpio*		X							Chronic	114715
Hagenaars et al. 2011	Fish	*Danio rerio*	X	X	X	X					Acute	152104
Hagenaars et al. 2014	Fish	*Danio rerio*		X							Chronic and acute	175658
Han and Fang 2010	Fish	*Xiphophorus helleri*		X							Chronic	151613
Han et al. 2015	Crustacean	*Tigriopus japonicus*		X							Chronic	175656
Hanson et al. 2005	Plants	*Myriophyllum sibiricum* and *M. spicatum*		X							Chronic	80833
Hazelton et al. 2012	Mollusk	*Lampsilis siliquoidea* and *Ligumia recta*	X	X							Acute	160209
Hoke et al. 2012	Fish, crustacean, algae	*Oncorhynchus mykiss* *D. magna* *P. subcapitata*					X				Acute	161077
Hoover et al. 2017	Amphibians	*Rana pipiens*	X	X					X		Chronic	176982
Hu et al. 2014	Algae	*Chlamydomonas reinhardtii and Scenedesmus obliquus*	X								Acute and chronic	177126
Huang et al. 2010	Fish	*Danio rerio*		X							Chronic	151614
Jacobson et al. 2010	Crustacean	*Monoporeia affinis*		X							Chronic	152160
Jantzen et al. 2016a	Fish	*Danio rerio*	X	X						X	Chronic	175223
Jeong et al. 2016	Crustacean	*Daphnia magna*		X							Chronic	177169

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Ji et al. 2008	Fish and Crustaceans	*Daphnia magna, Moina macrocopa* and *Oryzias latipes*	X	X							Chronic	114976
Jo et al. 2014	Fish	*Danio rerio*					X				Chronic	
Kalasekar et al. 2015	Fish	*Danio rerio*	X								Acute 4 days	172976
Keiter et al. 2012	Fish	*Danio rerio*		X							Chronic	160092
Kim et al. 2013	Amphibians	*Xenopus* sp	X								Acute	170608
Latala et al. 2008	Marine Algae	*Chlorella vulgaris, Skeletonema marinoi* and *Geitlerinema amphibium*	X					X		X	Acute	118463
Lee et al. 2017	Fish	*Oryzias latipes*	X								Chronic	177079
Li 2008	Planaria	*Dugesia japonica.*	X	X							Acute	111070
Li 2009	Planaria, crustacean, mollusk	*Dugesia japonica, green neon Neocaridina denticulate, Physa acuta*	X	X							Acute	118450
Li 2010	Crustacean	*Daphnia magna*	X	X							Chronic	152183
Liang et al. 2017	Crustacean	*Daphnia magna*		X							Chronic	177138
Liu et al. 2008	Algae	*Scenedesmus obliquus*		X		X					Acute	170323
Liu et al. 2014a	Marine mollusc	*Perna viridis*	X	X							Chronic	177196
Liu et al. 2015	Fish	*Danio rerio*								X	Chronic	181408
Liu et al. 2016	Worm	*Limnodrilus hoffmeisteri*		X							Acute	117071
Lu et al. 2015	Crustacean	*Daphnia magna*		X						X	Acute and Chronic	177104
MacDonald et al 2004	Insect	*Chironomus tentans*	X	X							Chronic	87173
Mhadhbi et al. 2012	Marine algae, echinoderm, crustacean, and fish	*Isochrysis galbana, Paracentrotus lividus, Siriella armata* and *Psetta maxima*	X	X							Acute	160548

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Oakes et al. 2004	Fish	*Pimephales promelas*	X								Chronic	105756
Oakes et al. 2005	Fish	*Pimephales promelas, Oncorhynchus mykiss, Semotilus atromaculatus, Notropis hudsonius,* and *Catostomus commersonii*		X							Acute	93441
Palmer and Krueger. 2001	Amphibians	*Xenopus*		X							Acute 4 days	175357
Park et al. 2015	Crustacean	*Macrophthalmus japonicus*.		X							Acute 4 days	177086
Qu et al. 2016	Worms	*Limnodrilus hoffmeisteri*		X							Acute 2 days	175703
Rosal et al. 2010	Algae and bacteria	*Vibrio fischeri Pseudokirchneriella subcapitata*	X	X		X					Chronic	151618
Sanderson et al. 2002	Crustaceans and rotifers	*Cyclops diaptomus, Cyclops strenuus, Cyclops canthocamptus staphylinus, Daphnia magna, Keratella quadrata, Phyllopoda sp., Echninorhynchus sp., Ostracoda sp., and total Rotifera sp*		X							Chronic	64956
Sanderson et al. 2003	Crustaceans and rotifers	*Daphnia magna; Cyclops canthocamptus staphylinus; Cylops diaptomus; Rotifera sp.*	X								Chronic	68253

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Sanderson et al. 2004	Crustaceans And rotifers	*Cyclops diaptomus, C. strenuus, Canthocamptus staphylinus, Daphnia magna, Keratella quadrata, Phyllopoda* sp., *Echninorhynchus* sp., *Ostracoda* sp., *and total Rotifera* sp.	X	X							Chronic	95705
San-Segundo et al. 2016	Amphibian	*Xenopus laevis*		X							Acute	175663
Sant et al. 2017	Fish	*Danio rerio*		X							Acute 4 days and chronic	175217
Sant et al. 2018	Fish	*Danio rerio*		X							Acute 4 days	178022
Sharpe 2010	Fish	*Danio rerio* and *Oncorhynchus mykiss*		X							Acute	151619
Shi et al. 2008	Fish	*Danio rerio*		X							Chronic	114603
Shi et al. 2009a	Fish	*Danio rerio*		X							Chronic	119304
Stengel et al. 2017a	Fish	*Danio rerio*	X	X							Acute	176328
Stengel et al. 2017b	Fish	*Danio rerio*		X							Acute	175499
Sutherland and Krueger 2001	Algae	*Navicula pelliculosa*		X							Acute 96 hr	175358
Tilton et al. 2008	Fish	*Oncorhynchus mykiss*	X								Chronic	113316
Ulhaq et al. 2013	Fish	*Danio rerio*	X	X	X	X	X			X	Chronic and acute	165818
Wang et al. 2011	Fish	*Danio rerio*		X							Chronic	164068
Wang et al. 2014	Rotifer	*Brachionus calyciflorus*			X			X			Acute and chronic	175717
Wang et al. 2017	Fish	*Danio rerio*		X							Acute	175190

Table F-1 Studies Accepted for Ecological Screening Level Development—Aquatic

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Wang et al. 2020	Fish	*Danio rerio*	X								Chronic	None
Wu et al. 2012	Marine fish	*Oryzias melastigma*		X							Chronic	159194
Xia and Niu 2017	Fish	*Danio rerio*		X							Acute	177144
Xu et al. 2013	Algae -2	*Chlorella pyrenoidosa* and *Selenastrum capricornutum*	X								Chronic and acute	170546
Yang et al. 2014	Fish -2 Amphibian-1 Crustacean-2 Insects -1 Worm-1 Mollusk -1 Algae-1	*Carassius auratus, pseudorasbora parva, bufo gargarizans, daphnia magna, macrobrachium Nipponese; Chironomus plumosus; limnodrilus hoffmeisteri, cipangopaludina cathayensis; Scenedesmus quadricauda*	X	X							Acute and chronic	175260
Yuan et al. 2014a	Planarian	*Dugesia japonica*	X	X							Acute	175659
Yuan et al. 2015	Planarian	*Dugesia japonica*	X								Acute	177055
Zhang et al. 2012	Fish	*Danio rerio*								X	Chronic	160553
Zhang et al. 2013	Rotifer	*Brachionus calyciflorus*	X	X							Acute and chronic	175669
Zhang et al. 2014	Rotifer	*Brachionus calyciflorus*	X	X							Chronic	168456
Zhang et al. 2016	Fish	*Danio rerio*								X	Chronic 180 days	175216
Zheng et al. 2012	Fish	*Danio rerio*	X	X						X	Acute	160547

Table F.1 Studies Accepted for Ecological Screening Level Development—Terrestrial

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
3M Co. 2001	Arthropod	*Apis*		X							Acute	181617
Abbott et al. 2007	Mammal	Mice	X								Chronic	
Abbott et al. 2009	Mammal	Mice		X							Acute	
Brignole et al. 2003	Plants	*Lactuca saliva, Lolium perenne, Lycopersicon esculentum, Allium cepa, Medicago saliva,* and *Linum usitatissimum*		X							Chronic	175361
Butenhoff et al. 2004	Mammal	Rat	X								Chronic	
Butenhoff et al. 2009	Mammals	Rat							X		Sub-chronic	
Butenhoff et al. 2012	Mammals	Rat		X							Chronic	
Case et al. 2001	Mammals -2	Rabbit and rat		X								
Chang et al. 2018	Mammal	Mice							X		Sub-chronic	
Chen et al. 2012	Mammal	Rat		X							Acute	
Cook et al. 1992	Mammal	Rat	X								Chronic	
Cui et al. 2009	Mammal	Rat	X	X							Chronic	
Das et al. 2008	Mammal	Mice			X						Chronic	
Das et al. 2015	Mammal	Mice								X	Chronic	
DeWitt et al. 2008	Mammal	Mice	X								Sub-chronic	
DeWitt et al. 2016	Mammal	Mice	X								Chronic	
DuPont Co. 1982	Mammal	Mice	X								Chronic	
DuPont Co. 1985	Mammal	Mice								X	Chronic	
DuPont Co. 1995	Mammal	Rat	X								Chronic	
Era et al. 2009	Mammal	Mice		X							Chronic	
Gadelhak 1993	Arthropod	*Blattella germanica*		X							Chronic	167754

Table F.1 Studies Accepted for Ecological Screening Level Development—Terrestrial

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Gallagher et al. 2003a	Bird	*Colinus virginianus*		X							Chronic	180082
Gallagher et al 2003b	Bird	*Anas platyrhynchos*		X							Chronic	180057
Gonzalez-Naranjo et al. 2014	Plant	*monocotyledonous Sorghum bicolor*	X								Acute	176911
Grasty et al. 2003	Mammal	Mice		X							Acute	
Harris and Birnbaum 1989	Mammals	Mice					X				Chronic	
Harris et al. 1989	Mammals	Mice					X				Acute	
Hines et al. 2009	Mammal	Mice	X								Chronic	
Iwai and Hoberman 2014	Mammal	Mice						X			Chronic	
Karnjanapiboon wong et al 2018	Earthworm	*Eisenia fetida*				X			X	X	Chronic	177143
Lau et al. 2003.	Mammals	Rat		X							Chronic	
Lau et al. 2006	Mammal	Mice	X								Chronic	
Lee et al. 2015	Mammal	Mice		X							Chronic	
Li et al. 2016	Mammal	Rats	X								Chronic	
Lieder et al. 2009a	Mammal	Rats				X					Sub-chronic	
Lieder et al. 2009b	Mammal	Rats				X					Sub-chronic	
Liu et al. 1996	Mammal	Rats	X								Chronic	
Loveless et al. 2006	Mammal	Rats and mice	X								Chronic	
Luebker et al. 2005a	Mammal	Rats		X							Chronic	
Luebker et al. 2005b	Mammal	Rats		X							Chronic	
Mommaerts et al. 2011	Arthropod	*Bombus terrestris*		X							Chronic	163148
Newsted et al. 2006	Birds-2	*Anas platyrhynchus* and *Colinus virginianus*		X							Chronic	175224

Table F.1 Studies Accepted for Ecological Screening Level Development—Terrestrial

Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Test Period	ECOTOX Ref. No.
Newsted et al. 2007	Birds-2	*Anas platyrhynchus* and *Colinus virginianus*		X							Chronic	175224
Newsted et al. 2008	Birds-2	*Anas platyrhynchus* and *Colinus virginianus*				X					Acute and Chronic	110984
Ngo et al. 2014	Mammal	Mice	X								Chronic	
Princz et al. 2018	Arthropods-2	*Folsomia candida*, and *Oppia nitens*.		X							Chronic	178027
Sindermann et al. 2002	Worm	*Eisenia foetida*		X							Acute	177116
Son et al. 2008	Mammal	Mice	X								Chronic	
Thibodeaux et al. 2003	Mammals	Rat and mouse		X							Chronic	
Thomford 2002	Mammal	Rats		X							Chronic	
Van Gossum et al. 2010	Arthropod	*Drosophila hydei*		X							Chronic	177127
Wang et al 2010	Arthropod	*Drosophila sp*	X								Chronic	177114
Wan et al. 2011	Mammal	*Mice*		X							Chronic	
White et al. 2011	Mammal	Mice	X								Chronic	
Wolf et al. 2007	Mammal	Mice	X								Chronic	
Wolf et al. 2010	Mammal	Mice								X	Chronic	
Xing et al. 2016	Mammal	Mice		X							Chronic	
Xu et al. 2013	Worms	*Eisenia foetida*		X							Acute	166647
Yahia et al. 2010	Mammal	Mice	X								Chronic	
Zareitalabad et al. 2013	Worm	*Aporrectodea caliginosa*	X	X							Chronic	175666
Zhao et al. 2011	Plant	*Brassica chinensis*	X	X							Chronic	175188
Zheng et al. 2016	Worm	*Eisenia foetida*	X	X							Chronic	176944
Zhou et al. 2016	Plant	*Triticum aestivum L*	X								Chronic	175702

TABLE F-2 STUDIES REJECTED FOR ECOLOGICAL SCREENING LEVEL DEVELOPMENT

Table F-2 Studies Rejected for Ecological Screening Level Development—Aquatic												
ECOTOX Ref No.[1]	**Author and Year**	**Major Taxa**	**Species**	**PFOA**	**PFOS**	**PFBA**	**PFBS**	**PFDA**	**PFHxA**	**PFHxS**	**PFNA**	**Reject Reason**
158213	Anselmo et al., 2011	Echinoderm	*Psammechinus miliaris*		X							Reject; no effect reported
166317	Arukwe et al. 2013	Fish	*Salmo salar*	X	X							Reject; only one treatment level
175685	Chen et al. 2016	Fish	*Danio rerio*		X							Reject; only one treatment level
157821	Cheng et al. 2011	Amphibians	*Xenopus laevis*		X							Reject no effects reported for growth development or reproduction
175649	Cheng et al. 2016	Fish	*Danio rerio*		X							Reject: only one treatment level used
175362	Desjardins et al. 2001	Algae	*Skeletonema costatum*		X							Reject, only one treatment level used
154960	Dorts et al. 2011	Fish	*Cottus gobio*		X							Reject; no effects reported for growth development or reproduction
175708	Du et al. 2013	Fish	*Danio rerio*	X								Reject; only NOEC for development and mortality
169773	Feng et al. 2015	fish	*Carassius auratus*	X	X							Reject; no effects reported for growth development or reproduction
177964	Giari et al. 2016	fish	*Cyprinus carpio*	X								Reject; no effects reported for growth, development, or reproduction
177139	Godfrey et al. 2017	Fish	*Danio rerio*	X		X						Reject; only one exposure level used
156287	Hagenaars et al. 2011	Fish	*Scophthalmus maximus*		X							Reject; only one treatment level used
175710	Hagenaars et al. 2013	Fish	*Danio rerio*	X								Reject because no effect on fecundity, fertility or hatching was found
156047	Huang et al. 2011	Fish	*Oryzias melastigma*		X							Reject; no ecologically relevant endpoint was assessed

Table F-2 Studies Rejected for Ecological Screening Level Development—Aquatic

ECOTOX Ref No.[1]	Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Reject Reason
176956	Huang et al. 2015	Fish	*Oryzias melastigma*		X							Reject; no effect on growth, mortality, or reproduction
177122	Huang et al. 2016	Fish	*Danio rerio*		X							Reject; no effects reported
160552	Inoue et al. 2012	Fish	*Cyprinus carpio*	X	X							Reject; no effects on growth, mortality, or reproduction
109137	Ishisbashi et al. 2008	Fish	*Oryzias latipes*					X				Reject; no effect on growth, mortality, or reproduction
175223	Jantzen et al. 2016b	Fish	*Danio rerio*	X	X						X	Reject; only one exposure concentration used
177166	Jantzen et al. 2017	Fish	*Danio rerio*	X								Reject; only one exposure concentration used
150289	Jeon et al. 2010a	Mollusk	*Crassostrea gigas*	X	X			X				Reject; no effects reported
175199	Jeon et al. 2010b	Fish	*Sebastes schlegeli*		X							Reject; no effects to growth, mortality or reproduction
177167	Keiter et al. 2016	Fish	*Danio rerio*		X							Reject; a mixture was used with only one PFOS treatment level
151615	Kim et al. 2010	Fish	*Cyprinus carpio*	X	X							Reject; no effects on growth reported after 4-day exposure
158519	Kim et al. 2011	Fish	*Danio rerio*		X							Reject; only one treatment level
177119	Li 2011	Fish	*Poecilia reticulate*	X	X							Reject; no effects on growth, mortality or reproduction
114574	Liu et al. 2008	Algae	*Scenedesmus obliquus*	X					X			Reject due to no effect on a relevant endpoint
116910	Liu et al. 2009	Algae	*Scenedesmus obliquus*		X							Reject; no effect found
170323	Liu et al. 2013	Fish	*Danio rerio*		X							Reject; only one treatment level used
177196	Liu et al. 2014b	Mollusc	*Perna viridis*	X	X			X			X	Reject; no effects on growth, mortality, or reproduction
170602	Lou et al. 2013	Amphibian	*Xenopus laevis*		X		X					Reject; no effect on growth mortality, or reproduction
177157	Manera et al. 2017	Fish	*Cyprinus carpio*	X								Reject; no effects on growth, mortality, or reproduction

Table F-2 Studies Rejected for Ecological Screening Level Development—Aquatic

ECOTOX Ref No.[1]	Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Reject Reason
178355	Marziali et al. 2019	Insect	*Chironomus riparius*	X	X							Reject because only one treatment level was used for PFOA
110755	Matsubara et al. 2006	Cilliate	*Paramecium caudatum*	X	X		X	X			X	Reject; studies cells
177070	Meng et al. 2016	Worms	*Limnodrilus hoffmeisteri*		X							Reject; one treatment level used
178388	Mitchell 2009	Amphibian	*Xenopus*					X			X	Reject; only one treatment level
175198	Mortensen et al. 2011	Fish	*Salmo salar*	X	X							Reject; no effect on growth, mortality or reproduction
175222	Oh et al. 2013	Fish	*Oryzias latipes*	X	X							Reject because only one treatment level; no effect on growth, mortality or reproduction
161191	Padilla et al. 2012	Fish	*Danio rerio*	X								Reject; high throughput screening study
175185	Preus-Olsen et al. 2014	Fish	*Gadus morhua*		X							Reject; no effect described
175667	Qiang et al. 2015	Fish	*Danio rerio*		X							Reject; no observed effect and only one treatment level
177202	Qiang et al. 2016a	Fish	*Cyprinus carpio*		X							Reject; only one treatment level was used; no effect reported
177094	Qiang et al. 2016b	Fish	*Danio rerio, Ctenopharyngodon idella, Hypostomus plecostomus*		X							Reject; no effects on growth, mortality, or reproduction
170799	Rodea-Palomares et al. 2015	Cyanobacteria	*Anabaena*	X	X							Reject; study of effects on bioluminescence
175716	Roland et al. 2014	Fish	*Anguilla anguilla*		X							Reject; no effect reported
177262	Rotondo et al. 2018	Fish	*Cyprinus carpio*	X								Reject; no affect reported on growth, mortality, or reproduction
177135	Sakurai et al. 2017	Worms	*Perinereis wilsoni*		X							Reject; only one treatment level used; no effect found
118237	Shi et al. 2009b	Fish	*Danio rerio*		X							Reject; only one treatment level

Table F-2 Studies Rejected for Ecological Screening Level Development—Aquatic

ECOTOX Ref No.[1]	Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Reject Reason
159201	Spachmo et al. 2012.	Fish	*Salmo salar*	X	X							Reject; only one treatment group;
175220	Stefani et al. 2014	Insect	*Chironomus riparius*	X	X		X					Reject; only one treatment level
175655	Ulhaq et al. 2015	Fish	*Danio rerio*	X								Reject; no effects on growth, mortality, or reproduction

Table F-2 Studies Rejected for Ecological Screening Level Development—Terrestrial												
ECOTOX Ref No.[a]	**Author and Year**	**Major Taxa**	**Species**	**PFOA**	**PFOS**	**PFBA**	**PFBS**	**PFDA**	**PFHxA**	**PFHxS**	**PFNA**	**Reject Reason**
94239	Abdellatif et al. 1990	Mammal	Rats	X								Reject; only one treatment level; No effects reported for growth, mortality or reproduction
N/A	Biegel et al. 2001	Mammals	Rats	X								Reject; one treatment level
151364	DuPont Co. 1965	Mammal	Dogs	X								Reject; no endpoint calculated
151364	DuPont Co. 1981	Mammal	Rats	X								Reject; no control
151364	DuPont Co. 1981	Mammal	Rats	X								Reject; no control
151364	DuPont Co. 1981	Mammal	Rats	X								Reject; no control
151364	DuPont Co. 1981	Mammal	Guinea pigs	X								Reject; no control
151364	DuPont Co. 1983	Mammal	Rats	X								Reject; no endpoint calculated
N/A	Fuentes et al. 2007	Mammal	Mice		X							Reject; only one treatment level
177180	He et al. 2016	Worm	*Eisenia fetida*	X								Reject; no effect on growth, reproduction, or mortality reported
178466	Hu et al. 2002	Mammal	Rats		X							Reject; only 1 treatment level used for live exposure
N/A	Kawabata et al. 2017	Mammal	Rats					X				Reject; one treatment level

Table F-2 Studies Rejected for Ecological Screening Level Development—Terrestrial

ECOTOX Ref No.[a]	Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Reject Reason
N/A	Kawashima et al. 1995	Mammal	Rats	X				X				Reject; no effect reported
N/A	Klaunig et al. 2015	Mammal	Rats						X			Reject; high control mortality
104399	Martin et al. 2007	Mammals	Rats	X	X							Reject; only one treatment level used
N/A	Ngo et al. 2014	Mammals	Mice		X							Reject; no effect documented for PFOS
N/A	Pastoor et al. 1987	Mammals	Rats	X								Reject; only one treatment level
N/A	Qazi et al. 2010	Mammals	Mice		X							Reject; only one treatment level
N/A	Rogers 2014	Mammals	Rats		X						X	Reject; one treatment level
175684	Smits and Nain 2013	Bird	*Coturnix japonica*	X								Reject; no effect on growth, reproduction, or mortality reported
N/A	Staples et al. 1984	Mammal	Rats	X								Reject; only one treatment level used
N/A	Vetvicka and Vetvickova 2013	Mammal	Mice	X	X							Reject; only one treatment level
N/A	White et al. 2007	Mammal	Mice	X								Reject; only one treatment level
N/A	Xie et al. 2003	Mammal	Mice	X								Reject; only one exposure dose
N/A	Yang, 2000	Mammal	mice	X								Reject; only one exposure dose

Table F-2 Studies Rejected for Ecological Screening Level Development—Terrestrial

ECOTOX Ref No.[a]	Author and Year	Major Taxa	Species	PFOA	PFOS	PFBA	PFBS	PFDA	PFHxA	PFHxS	PFNA	Reject Reason
N/A	Yang et al. 2002	Mammal	Mice	X								Reject; only one exposure dose
177158	Yuan et al. 2017	Worm	*Eisenia fetida*	X	X							Reject; only LC_{50} calculated

[a] Papers with N/A in the reference number column were not found through ECOTOX.

F.1 EVALUATIONS OF STUDIES OF AQUATIC BIOTA FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFOA

Reference: Arukwe, A., M.V. Cangialosi, R.J. Letcher, E. Rocha, and A.S. Mortensen. 2013. "Changes in Morphometry and Association Between Whole-Body Fatty Acids and Steroid Hormone Profiles in Relation to Bioaccumulation Patterns in Salmon Larvae Exposed to Perfluorooctane Sulfonic or Perfluorooctane Carboxyl." *Aquat. Toxicol*.130/131: 219–230.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because only one exposure dose.	

Reference: Barmentlo, S., J.M. Stel, M. van Doorn, C. Eschauzier, P. de Voogt, M. H.S. Kraak. 2015. "Acute and chronic toxicity of short chained perfluoroalkyl substances to *Daphnia magna*." *Aquat. Environmental Pollution* 198: 47–53.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept.	

Reference: Boudreau, T.M. 2002. *Toxicity of Perfluorinated Organic Acids to Selected Freshwater Organisms Under Laboratory and Field Conditions*. M.S. Thesis, University of Guelph, Ontario, Canada.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Colombo, I., Watze deWolf, R.S. Thompson, D.G. Farrard, R.A. Hoke, J. L'Haridonf. 2008. "Acute and chronic aquatic toxicity of ammonium perfluorooctanoate (APFO) to freshwater organisms." ***Ecotoxicology and Environmental Safety*** **71: 749–756.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Corrales, J., L.A. Kristofco, W.B. Steele, G.N. Saari, J. Kostal, E.S. Williams, M. Mills, E.P. Gallagher, T.J. Kavanagh. 2017. "Toward the Design of Less Hazardous Chemicals: Exploring Comparative Oxidative Stress in Two Common Animal Models." *Chem. Res. Toxicol.* 30(4): 893–904.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ding, G.H., T. Fromel, E.J. Van den Brandhof, R. Baerselman, and W.J.G.M. Peijnenburg. 2012a. "Acute Toxicity of Poly- and Perfluorinated Compounds to Two Cladocerans, *Daphnia magna* and *Chydorus sphaericus*." *Environ. Toxicol. Chem*. 31(3): 605–610.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ding, G., M. Wouterse, R. Baerselman, and W.J.G.M. Peijnenburg. 2012b. "Toxicity of Polyfluorinated and Perfluorinated Compounds to Lettuce (*Lactuca sativa*) and Green Algae (*Pseudokirchneriella subcapitata*)." *Arch. Environ. Contam. Toxicol*. 62(1): 49–55.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal only**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ding, G., J. Zhang, Y. Chen, L. Wang, M. Wang, D. Xiong, and Y. Sun. 2013. "Combined Effects of PFOS and PFOA on Zebrafish (*Danio rerio*) Embryos." *Arch. Environ. Contam. Toxicol.* 64(4): 668–675.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Du, G., H. Huang, J. Hu, Y. Qin, D. Wu, L. Song, Y. Xia, and X. Wang. 2013. "Endocrine-Related Effects of Perfluorooctanoic Acid (PFOA) in Zebrafish, H295R Steroidogenesis and Receptor Reporter Gene Assays." *Chemosphere* 91(8): 1099–1106.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	**Y**
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; NOEC for development and mortality	

Reference: DuPont Co. 1994. 96-hour LC_{50}. Lepomis macrochirus (bluegill sunfish).Unpublished Data, Haskell Laboratory Report No. 61-94. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate, (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: DuPont Co. 1994. 96-hour LC_{50} Oncorhynchus mykiss (rainbow trout).Unpublished Data, Haskell Laboratory Report No. 61-94. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate, (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Fabbri, R., M. Montagna, T. Balbi, E. Raffo, F. Palumbo, and L. Canesi. 2014. "Adaptation of the Bivalve Embryotoxicity Assay for the High Throughput Screening of Emerging Contaminants in *Mytilus galloprovincialis*." *Mar. Environ. Res.* 99: 1-8.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Feng, M., Q. He, L. Meng, X. Zhang, P. Sun, and Z. Wang. 2015. "Evaluation of Single and Joint Toxicity of Perfluorooctane Sulfonate, Perfluorooctanoic Acid, and Copper to *Carassius auratus* Using Oxidative Stress Biomarkers." *Aquat. Toxicol.* 161: 108–116.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects reported for growth development or reproduction.	

Reference: Giari, L., F. Vincenzi, S. Badini, C. Guerranti, B.S. Dezfuli, E.A. Fano, and G. Castaldelli. 2016. "Common Carp *Cyprinus carpio* Responses to Sub-Chronic Exposure to Perfluorooctanoic Acid." *Environ. Sci. Pollut. Res. Int.* 23(15): 15321–15330.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects reported for growth development or reproduction	

Reference: Godfrey, A., A. Abdel-Moneim, and M.S. Sepulveda. 2017. "Acute mixture toxicity of halogenated chemicals and their next generation counterparts on zebrafish embryos." *Chemosphere* 181: 710–712.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Godfrey, A., B. Hooser, A. Abdelmoneim, K.A. Horzmann, J.L. Freemanc, and M.S. Sepulveda. 2017. "Thyroid Disrupting Effects of Halogenated and Next Generation Chemicals on the Swim Bladder Development of Zebrafish." ***Aquat. Toxicol.*** **193: 228–235.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; Only one exposure level used	

Reference: Gonzalez-Naranjo, V., and K. Boltes. 2014. "Toxicity of Ibuprofen and Perfluorooctanoic Acid for Risk Assessment of Mixtures in Aquatic and Terrestrial Environments." ***Int. J. Environ. Sci. Technol.*** **(Tehran) 11(6): 1743–1750.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hagenaars, A., L. Vergauwen, W. De Coen, and D. Knapen. 2011. "Structure-Activity Relationship Assessment of Four Perfluorinated Chemicals Using a Prolonged Zebrafish Early Life Stage Test." *Chemosphere* 82: 764–772.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hagenaars, A., L. Vergauwen, D. Benoot, K. Laukens, and D. Knapen. 2013. "Mechanistic Toxicity Study of Perfluorooctanoic Acid in Zebrafish Suggests Mitochondrial Dysfunction to Play a Key Role in PFOA Toxicity." *Chemosphere* 91(6): 844–856.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control (s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because no effect on fecundity, fertility or hatching was found.	

Reference: Hazelton, P.D., W.G. Cope, T.J. Pandolfo, S. Mosher, M.J. Strynar, M.C. Barnhart, and R.B. Bringolf. 2012. "Partial Life-Cycle and Acute Toxicity of Perfluoroalkyl Acids to Freshwater Mussels." *Chem*. 31(7): 1611–1620.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hoover, G.M., M.F. Chislock, B.J. Tornabene, S.C. Guffey, Y.J. Choi, C. De Perre, J.T. Hoverman, L.S. Lee, and M.S. Sepu. 2017. "Uptake and Depuration of Four Per/Polyfluoroalkyl Substances (PFASs) in Northern Leopard Frog *Rana pipiens* Tadpoles." *Environ. Sci. Technol. Lett.* 4(10): 399–403.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hu, C., Q. Luo, and Q. Huang. 2014. "Ecotoxicological Effects of Perfluorooctanoic Acid on Freshwater Microalgae *Chlamydomonas reinhardtii* and *Scenedesmus obliquus*." *Environ. Toxicol. Chem*. 33(5): 1129–1134.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Inoue, Y., N. Hashizume, N. Yakata, H. Murakami, Y. Suzuki, E. Kikushima, and M. Otsuka. 2012. "Unique Physicochemical Properties of Perfluorinated Compounds and Their Bioconcentration in Common Carp *Cyprinus carpio* L." *Arch. Environ. Contam. Toxicol.* 62(4): 672–680.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effects were reported for growth, mortality or reproduction	

Reference: Jantzen, C.E., K.A. Annunziato, S.M. Bugel, and K.R. Cooper. 2016a. "PFOS, PFNA, and PFOA Sub-Lethal Exposure to Embryonic Zebrafish Have Different Toxicity Profiles in Terms of Morphometrics, Behavior and Gene Expression." *Aquat. Toxicol.* 175: 160–170.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20% for all tx**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Jantzen, C.E., K.A. Annunziato, S.M. Bugel, and K.R. Cooper. 2016b. "Behavioral, morphometric, and gene expression effects in adult zebrafish (*Danio rerio*) embryonically exposed to PFOA, PFOS, and PFNA." *Aquat. Toxicol.* 180: 123–130.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20% for all tx**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only 1 treatment level	

Reference: Jantzen, C.E., F. Toor, K.A. Annunziato, and K.R. Cooper. 2017. "Effects of Chronic Perfluorooctanoic Acid (PFOA) at Low Concentration on Morphometrics, Gene Expression, and Fecundity in Zebrafish (*Danio rerio*)." *Reprod. Toxicol.* 69: 34–42.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject. Only one exposure concentration used	

Reference: Jeon, J., K. Kannan, H.K. Lim, H.B. Moon, J.S. Ra, and S.D. Kim. 2010a. "Bioaccumulation of Perfluorochemicals in Pacific Oyster Under Different Salinity Gradients." *Environ. Sci. Technol.* 44(7): 2695–2701.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject no effects reported.	

Reference: Ji, K., Y. Kim, S. Oh, B. Ahn, H. Jo, and K. Choi. 2008. "Toxicity of Perfluorooctane Sulfonic Acid and Perfluorooctanoic Acid on Freshwater Macroinvertebrates (*Daphnia magna and Moina macrocop*a) and Fish (*Oryzias latipes*)." *Environ. Toxicol. Chem*. 27(10): 2159–2168.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Kalasekar, S.M., E. Zacharia, N. Kessler, N.A. Ducharme, J.A. Gustafsson, I.A. Kakadiaris, and M. Bondesson. 2015. "Identification of Environmental Chemicals that Induce Yolk Malabsorption in Zebrafish Using Automated Image Segmentation." *Reprod. Toxicol.* 55: 20–29.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Kim, W.K., S.K. Lee, and J. Jung. 2010. "Integrated Assessment of Biomarker Responses in Common Carp (*Cyprinus carpio*) Exposed to Perfluorinated Organic Compounds." *J. Hazard. Mater*. 180(1-3): 395–400.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effects on growth reported after 4d exposure	

Reference: Kim, M., J. Son, M.S. Park, Y. Ji, S. Chae, C. Jun, J.S. Bae, T.K. Kwon, Y.S. Choo, H. Yoon, D. Yoon, J. Ryoo, S.H. Kim. 2013. "In Vivo Evaluation and Comparison of Developmental Toxicity and Teratogenicity of Perfluoroalkyl Compounds Using Xenopus Embryos." *Chemosphere* 93(6): 1153–1160.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Latala, A., M. Nedzi, and P. Stepnowski. 2008. "Acute Toxicity Assessment of Perfluorinated Carboxylic Acids Towards the Baltic Microalgae." ***Environ. Toxicol. Pharmacol.*** **28(2): 167–171.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Lee, J.W., J.W. Lee, K. Kim, Y.J. Shin, J. Kim, S. Kim, H. Kim, P. Kim, and K. Park. 2017. "PFOA-Induced Metabolism Disturbance and Multi-Generational Reproductive Toxicity in *Oryzias latipes*." *J. Hazard. Mater*. 340: 231–240.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2008. "Effects of Nonionic and Ionic Surfactants on Survival, Oxidative Stress, and Cholinesterase Activity of Planarian." *Chemosphere* 70(10): 1796–1803.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2009. "Toxicity of Perfluorooctane Sulfonate and Perfluorooctanoic Acid to Plants and Aquatic Invertebrates." ***Environ. Toxicol.*** **24(1): 95–101.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2010. "Chronic Effects of Perfluorooctane Sulfonate and Ammonium Perfluorooctanoate on Biochemical Parameters, Survival and Reproduction of *Daphnia magna*." *J. Health Sci*. 56(1): 104–111.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2011. "Changes of Cholinesterase and Carboxylesterase Activities in Male Guppies, *Poecilia reticulate*, After Exposure to Ammonium Perfluorooctanoate, but not to Perfluorooctane Sulfonate." *Fresenius Environ. Bull.* 20(8a): 2065–2070.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects on ecologically relevant endpoints reported.	

Reference: Liu, W., S. Chen, X. Quan, and Y.H. Jin. 2008. "Toxic Effect of Serial Perfluorosulfonic and Perfluorocarboxylic Acids on the Membrane System of a Freshwater Alga Measured by Flow Cytometry." *Environ. Toxicol. Chem*. 27(7): 1597–1604.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject due to no effect on a relevant endpoint	

Reference: Liu, C., K.Y.H. Gin, and V.W.C. Chang. 2014a. "Multi-Biomarker Responses in Green Mussels Exposed to PFCs: Effects at Molecular, Cellular, and Physiological Levels." *Environ. Sci. Pollut. Res.* 21: 2785–2794.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, C., V.W.C. Chang, and K.Y.H. Gin. 2014b. "Oxidative Toxicity of Perfluorinated Chemicals in Green Mussel and Bioaccumulation Factor Dependent Quantitative Structure-Activity Relationship." *Environ. Toxicol. Chem*. 33(10): 2323–2332.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects reported for growth, mortality or reproduction	

Reference: MacDonald, M.M., A.L. Warne, N.L. Stock, S.A. Mabury, K.R. Solomon, and P.K. Sibley. 2004. "Toxicity of Perfluorooctane Sulfonic Acid and Perfluorooctanoic Acid to *Chironomus tentans*." *Environ. Toxicol. Chem*. 23(9): 2116–2123.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**67%, which they say is acceptable.**
A calculated endpoint is reported (LOEL, LOAEC, NOAEC, NOAEL EC10 and EC20)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Manera, M., L. Giari, F. Vincenzi, C. Guerranti, J.A. DePasquale, and G. Castaldelli. 2017. "Texture Analysis in Liver of Common Carp (*Cyprinus carpio*) Sub-Chronically Exposed to Perfluorooctanoic Acid." *Ecol. Indic.* 81: 54–64.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; not effects on growth, mortality, or reproduction reported	

Reference: Marziali, L., F. Rosignoli, S. Valsecchi, S. Polesello, and F. Stefani. 2019. "Effects of Perfluoralkyl Substances (PFASs) on a Multigenerational Scale: A Case Study with *Chironomus riparius* (Diptera, Chironomidae)." *Environ. Toxicol. Chem*. 38 No. 5: 988-999.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because only one treatment level was used for PFOA	

Reference: Matsubara, E., K. Harada, K. Inoue, and A. Koizumi. 2006. "Effects of Perfluorinated Amphiphiles on Backward Swimming in *Paramecium caudatum*." *Biochem. Biophys. Res. Commun*. 339(2): 554–561.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**Y**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; studies cells	

Reference: Mhadhbi, L., D. Rial, S. Perez, and R. Beiras. 2012. "Ecological Risk Assessment of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) in Marine Environment Using *Isochrysis galbana, Paracentrotus lividus, Siriella armata* and *Psetta maxima*." *J. Environ. Monit.* 14(5): 1375–1382.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Oakes, K.D., P.K. Sibley, K.R. Solomon, S.A. Mabury, and G.J. Van der Kraak. 2004. "Impact of Perfluorooctanoic Acid on Fathead Minnow (*Pimephales promelas*) Fatty Acyl-CoA Oxidase Activity, Circulating Steroids, and Reproduction in Outdoor Microcosms." *Aquat. Toxicol.* 193: 228–235.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Mortensen, A.S., R.J. Letcher, M.V. Cangialosi, S. Chu, and A. Arukwe. 2011. "Tissue Bioaccumulation Patterns, Xenobiotic Biotransformation and Steroid Hormone Levels in Atlantic Salmon (*Salmo salar*) Fed a Diet Containing Perfluorooctane Sulfonic or Perfluorooctane Carboxylic Acids." *Chemosphere* 83(8): 1035–1044.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because there was no effect on the relevant endpoint .	

Reference: Oh, J.H., H.B. Moon, and E.S. Choe. 2013. "Alterations in Differentially Expressed Genes After Repeated Exposure to Perfluorooctanoate and Perfluorooctanesulfonate in Liver of *Oryzias latipes*." *Arch. Environ. Contam. Toxicol*. 64(3): 475–483.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because only one treatment level used and not effect on relevant endpoints was found	

Reference: Padilla, S., D. Corum, B. Padnos, D.L. Hunter, A. Beam, K.A. Houck, N. Sipes, N. Kleinstreuer, T. Knudsen, D.J. Dix. 2012. "Zebrafish Developmental Screening of the ToxCast Phase I Chemical Library." ***Reprod. Toxicol.*** **33(2): 174–187.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; high throughput screening study.	

Reference: Rodea-Palomares, I., M. Makowski, S. Gonzalo, M. Gonzalez-Pleiter, F. Leganes, and F. Fernandez-Pinas. 2015. "Effect of PFOA/PFOS Pre-Exposure on the Toxicity of the Herbicides 2,4-D, Atrazine, Diuron and Paraquat to a Model Aquatic Photosynthetic Microorganism." *Chemosphere* 139: 65–72.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; study of effects on bioluminescence.	

Reference: Rosal, R., I. Rodea-Palomares, K. Boltes, F. Fernandez-Pinas, F. Leganes, and A. Petre. 2010. "Ecotoxicological Assessment of Surfactants in the Aquatic Environment: Combined Toxicity of Docusate Sodium with Chlorinated Pollutants." *Chemosphere* 81(2): 288–293.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Rotondo, J.C., L. Giari, C. Guerranti, M. Tognon, G. Castaldelli, E.A. Fano, and F. Martini. 2018. "Environmental Doses of Perfluorooctanoic Acid Change the Expression of Genes in Target Tissues of Common Carp." ***Environ. Toxicol. Chem*****. 37(3): 942–948.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no affect reported on growth, mortality or reproduction	

Reference: Sanderson, H., T.M. Boudreau, S.A. Mabury, and K.R. Solomon. 2003. "Impact of Perfluorooctanoic Acid on the Structure of the Zooplankton Community in Indoor Microcosms." *Aquat. Toxicol*. 62(3): 227–234.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**N**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sanderson, H., T.M. Boudreau, S.A. Mabury, and K.R. Solomon. 2004. "Effects of perfluorooctane sulfonate and perfluorooctanoic acid on the zooplanktonic community." *Ecotoxicol. Environ. Saf.* 58(1): 68–76.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Spachmo, B., and A. Arukwe. 2012. "Endocrine and Developmental Effects in Atlantic Salmon (*Salmo salar*) Exposed to Perfluorooctane Sulfonic or Perfluorooctane Carboxylic Acids." *Aquat. Toxicol.* 108: 112–124.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because only one treatment group	

Reference: Stefani, F., M. Rusconi, S. Valsecchi, and L. Marziali. 2014. "Evolutionary Ecotoxicology of Perfluoralkyl Substances (PFASs) Inferred from Multigenerational Exposure: A Case Study with *Chironomus riparius* (Diptera, Chironomidae)." *Aquat. Toxicol.* 156: 41–51.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; 1 treatment level	

Reference: Stengel, D., S. Wahby, and T. Braunbeck. 2017a. "In Search of a Comprehensible Set of Endpoints for the Routine Monitoring of Neurotoxicity in Vertebrates: Sensory Perception and Nerve Transmission in Zebrafish (*Danio rerio*) Embryos." *Environ. Sci. Pollut. Res. Int.* 12: 19.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Tilton, S.C., G.A. Orner, A.D. Benninghoff, H.M. Carpenter, J.D. Hendricks, C.B. Pereira, and D.E. Williams. 2008. "Genomic Profiling Reveals an Alternate Mechanism for Hepatic Tumor Promotion by Perfluorooctanoic Acid in Rainbow Trout." *Environ. Health Perspect*. 116(8): 1047–1055.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ulhaq, M., G. Carlsson, S. Orn, and L. Norrgren. 2013. "Comparison of Developmental Toxicity of Seven Perfluoroalkyl Acids to Zebrafish Embryos." ***Environ. Toxicol. Pharmacol.*** **36: 423–426.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ulhaq, M., M. Sundstrom, P. Larsson, J. Gabrielsson, A. Bergman, L. Norrgren, and S. Orn. 2015. "Tissue Uptake, Distribution and Elimination of 14C-PFOA in Zebrafish (*Danio rerio*)." *Aquat. Toxicol.* 163: 148–157.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effects on growth, mortality or reproduction detected.	

Reference: Xu, D., C. Li, H. Chen, and B. Shao. 2013. "Cellular Response of Freshwater Green Algae to Perfluorooctanoic Acid Toxicity." ***Ecotoxicol. Environ. Saf.*** **88: 103–107.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Yang, S., F. Xu, F. Wu, S. Wang, and B. Zheng. 2014. "Development of PFOS and PFOA Criteria for the Protection of Freshwater Aquatic Life in China." *Sci. Total Environ*. 470/471: 677–683.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Yuan, Z., J. Zhang, B. Zhao, Z. Miao, and X. Wu. 2016. "Effects of Perfluorooctanoic Acid on Neural Genes Expression and Neuronal Morphology in the Planarian *Dugesia japonica*." *Chem. Ecol.* 32(6): 575–582.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no ecologically relevant endpoint	

Reference: Yuan, Z., J. Zhang, Y. Zhang, H. Zhen, and Y. Sun. 2015. "The Effect of Perfluorooctanoic Acid on the Planarian *Dugesia japonica*." *Pol. J. Environ. Stud*. 24(2): 801–807.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhai, Y., X. Xia, X. Zhao, H. Dong, B. Zhu, N. Xia, and J. Dong. 2016. "Role of Ingestion Route in the Perfluoroalkyl Substance Bioaccumulation by *Chironomus plumosus* Larvae in Sediments Amended with Carbonaceous Materials." *J. Hazard. Mater*. 302: 404–414.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because no effect on mortality reported and only 1 pfoa treatment level used	

Reference: Zhang, L., J. Niu, Y. Li, Y. Wang, and D. Sun. 2013. "Evaluating the Sub-Lethal Toxicity of PFOS and PFOA Using Rotifer *Brachionus calyciflorus*." *Environ. Pollut.* 180: 34–40.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhang, L., J. Niu, Y. Wang, J. Shi, and Q. Huang. 2014. "Chronic Effects of PFOA and PFOS on Sexual Reproduction of Freshwater Rotifer *Brachionus calyciflorus*." *Chemosphere* 114: 114–120.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept.	

Reference: Zheng, X.M., H.L. Liu, W. Shi, S. Wei, J.P. Giesy, and H.X. Yu. 2012. "Effects of Perfluorinated Compounds on Development of Zebrafish Embryos." *Environ. Sci. Pollut. Res.* 19(7): 2498–2505.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.2 EVALUATIONS OF STUDIES OF TERRESTRIAL BIOTA FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFOA

Reference: Abdellatif, A.G., V. Preat, J. Vamecq, R. Nilsson, and M. Roberfroid. 1990. "Peroxisome Proliferation and Modulation of Rat Liver Carcinogenesis by 2,4-Dichlorophenoxyacetic Acid, 2,4,5-Trichlorophenoxyacetic Acid, Perfluorooctanoic Acid and Nafenopin." *Carcinogenesis* 11(11): 1899–1902.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level; appears to expose test organisms to multiple toxicants. No effects reported for growth, mortality, or reproduction.	

Reference: Du, W., et al. 2020. "Response of Cucumber (*Cucumis Sativus*) to Perfluorooctanoic Acid in Photosynthesis and Metabolomics." ***Science of The Total Environment*****. 724: 138257.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**NA**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: DuPont Co. 1965. "Acute Toxicity Male dogs/beagle." Unpublished Data, Haskell Laboratory Report No. 123-65. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**N**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**NA**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, no endpoint calculated	

Reference: DuPont Co. 1981. "Oral LD_{50} Male rats/Crl:CD®." Unpublished data, Haskell Laboratory Report No. 567-81. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**N**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**NA**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; no control	

Reference: DuPont Co. 1981. "Male and female rats/Crl:CD®." DuPont Co. (1981). Unpublished Data, Haskell Laboratory Report No. 295-81. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**N**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**NA**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, no control	

Reference: DuPont Co. 1981. "Oral LD_{50} Male and female mice/CD-1DuPont Co." Unpublished Data, Haskell Laboratory Report No. 329-81. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**N**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**NA**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, no control	

Reference: DuPont Co. 1981. "Oral LD_{50} Male and female guinea pigs/Duncan Hartley." Unpublished Data, Haskell Laboratory Report No. 291-81. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**N**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**NA**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, no control	

Reference: DuPont Co. 1982. "14-Day Feeding Study Mice/Crl®:CD-1." Unpublished Data, Haskell Laboratory Report No. 12-82. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: DuPont Co. 1983. "Repeated Dose Oral Toxicity Study Mice/CD-1 and Rats/Crl:CD®." Unpublished Data, Haskell Laboratory Report No. 138-83. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, no endpoint calculated	

Reference: DuPont Co. 1995. "14-Day Feeding Study Rat/Crl:CD®BR." Unpublished Data, Haskell Laboratory Report No. 326-95. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Gonzalez-Naranjo, V., and K. Boltes. 2014. "Toxicity of Ibuprofen and Perfluorooctanoic Acid for Risk Assessment of Mixtures in Aquatic and Terrestrial Environments." ***Int. J. Environ. Sci. Technol.*** **(Tehran) 11(6): 1743–1750.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: He, W., M. Megharaj, and R. Naidu. 2016. "Toxicity of Perfluorooctanoic Acid Towards Earthworm and Enzymatic Activities in Soil." ***Environ. Monit. Assess.*** **188(7): 7.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; no effect on growth, reproduction, or mortality reported.	

Reference: Martin, M.T., R.J. Brennan, W. Hu, E. Ayanoglu, C. Lau, H. Ren, C.R. Wood, J.C. Corton, R.J. Kavlock, and D.J. Dix. 2007. "Toxicogenomic Study of Triazole Fungicides and Perfluoroalkyl Acids in Rat Livers Predicts Toxicity and Categorizes Chemicals Based on Mechanisms of Toxicity." ***Toxicol. Sci.*** **97(2): 595–613.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level used	

Reference: Smits, J.E.G., and S. Nain. 2013. "Immunomodulation and Hormonal Disruption Without Compromised Disease Resistance in Perfluorooctanoic Acid (PFOA) Exposed Japanese Quail." *Environ. Pollut.* 179: 13–18.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; No effect on growth, reproduction, or mortality reported	

Reference: Wang, J., Y. Li, L. Yang, H. Zhang, J. Dai. 2010. "Disturbance of perfluorooctanoic acid on development and behavior in Drosophila larvae." ***Environ. Environ. Toxicol. Chem*****. 29: 2117–2122.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects are caused by a single chemical stressor (i.e., no mixture testing in laboratory studies.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Wang, J., G. Shi, J. Yao, N. Sheng, R. Cui, Z. Su, Y. Guo, J. Dai. 2020. "Perfluoropolyether carboxylic acids (novel alternatives to PFOA) impair zebrafish posterior swim bladder development via thyroid hormone disruption." *Environ. International*. 134.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects are caused by a single chemical stressor (i.e., no mixture testing in laboratory studies.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Yuan, Z., J. Zhang, L. Zhao, J. Li, and H. Liu. 2017. "Effects of Perfluorooctanoic Acid and Perfluorooctane Sulfonate on Acute Toxicity, Superoxide Dismutase, and Cellulase Activity in the Earthworm *Eisenia fetida*." *Environ. Sci. Pollut. Res. Int.* 24(22): 18188–18194.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject only LC_{50} calculated	

Reference: Zareitalabad, P., J. Siemens, F. Wichern, W. Amelung, and R.G. Joergensen. 2013. "Dose-Dependent Reactions of *Aporrectodea caliginosa* to Perfluorooctanoic Acid and Perfluorooctanesulfonic Acid in Soil." *Ecotoxicol. Environ. Saf.* 95: 39–43.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan. 2011. "Phytotoxicity of PFOS and PFOA to *Brassica chinensis* in Different Chinese Soils." *Ecotoxicol. Environ. Saf.* 74(5): 1343–1347.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Nominal**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Zheng, X.Q., Y.J. Shi, Y.L. Lu, and X.B. Xu. 2016. "Growth Inhibition and DNA Damage in the Earthworm (*Eisenia fetida*) Exposed to Perfluorooctane Sulphonate and Perfluorooctanoic." *Acid. Chem. Ecol.* 32(2): 103–116.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Zhou, L., M. Xia, L. Wang, and H. Mao. 2016. "Toxic Effect of Perfluorooctanoic Acid (PFOA) on Germination and Seedling Growth of Wheat (*Triticum aestivum L.*)." *Chemosphere* 159: 420–425.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Nominal**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, LOAEC, NOAEC, NOAEL EC_{10} and EC_{20})	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.3 EVALUATIONS OF PFOA STUDIES OF RODENTS

Reference: 3M. 1983. "Two year oral (diet) toxicity/carcinogenicity study of fluorochemical FC-143 in rats." Washington, DC: U.S. Environmental Protection Agency. Submitted to the U.S. Environmental Protection Agency under TSCA Section 8E. OTS0204926-1.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	
Human or primate subjects.	
In vitro studies, including cell cultures and excised tissues.	
Methods for measuring contaminants.	
Only modeling results reported.	
No viable plant or animal present or tested.	
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	
Data developed only from quantitative-structure activity relationships.	
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	
Assessment of toxicity in the field over a period of time.	
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	
The chemical form and concentration are reported.	
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	
ACCEPT/REJECT: Publication not yet obtained	

Reference: Abbott, B.D., C.J. Wolf, J.E. Schmid, et al. 2007. "Perfluorooctanoic acid (PFOA)-induced developmental toxicity in the mouse is dependent on expression of peroxisome proliferator activated receptor-alpha." *Toxicol. Sci.* 98(2): 571–581.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Biegel, L.B., M.E. Hurtt, S.R. Frame, et al. 2001. "Mechanisms of extrahepatic tumor induction by peroxisome proliferators in male CD rats." ***Toxicol. Sci.*** **60(1): 44–55.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; one treatment level	

Reference: Butenhoff, J.L., G.L. Kennedy, S.R. Frame, et al. 2004. "The reproductive toxicology of ammonium perfluorooctanoate (APFO) in the rat." ***Toxicology*** **196(1-2): 95–116.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Cook, J.C., S.M. Murray, S.R. Frame, et al. 1992. "Induction of Leydig cell adenomas by ammonium perfluorooctanoate: A possible endocrine-related mechanism." *Toxicol. Appl. Pharmacol.* 113(2): 209–217.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Cui, L., Q.F. Zhou, C.Y. Liao, et al. 2009. "Studies on the toxicological effects of PFOA and PFOS on rats using histological observation and chemical analysis." ***Arch. Environ. Contam. Toxicol.*** **56(2): 338–349.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: DeWitt, J.C., C.B. Copeland, M.J. Strynar, and R.W. Luebke. 2008. "Perfluorooctanoicacid-induced immunomodulation in adult C57BL/6 J or C57BL/6 N female mice." *Environmental Health Perspectives* 116(5): 644–650.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: DeWitt, J.C., W.C. Williams, N.J. Creech, et al. 2016. "Suppression of antigen-specific antibody responses in mice exposed to perfluorooctanoic acid: Role of PPARalpha and T- and B-cell targeting." *J. Immunotoxicol.* 13(1): 38–45.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Griffith, F.D., J.E. Long. 1980. "Animal toxicity studies with ammonium perfluorooctanoate." ***Am. Ind. Hyg. Assoc. J.*** **41(8): 576–583.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	
Human or primate subjects.	
In vitro studies, including cell cultures and excised tissues.	
Methods for measuring contaminants.	
Only modeling results reported.	
No viable plant or animal present or tested.	
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	
Data developed only from quantitative-structure activity relationships.	
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	
Assessment of toxicity in the field over a period of time.	
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	
The chemical form and concentration are reported.	
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	
ACCEPT/REJECT: Haven't obtained a copy of the article	

Reference: Hines, E.P., S.S. White, J.P. Stanko, et al. 2009. "Phenotypic dichotomy following developmental exposure to perfluorooctanoic acid (PFOA) in female CD-1 mice: Low doses induce elevated serum leptin and insulin, and overweight in mid-life." ***Mol. Cell. Endocrinol*****. 304(1-2): 97–105.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Kawashima, Y., H. Kobayashi, H. Miura, et al. 1995. "Characterization of hepatic responses of rat to administration of perfluorooctanoic and perfluorodecanoic acids at low levels." *Toxicology* 99(3): 169–178.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; no effect reported	

Reference: Lau, C., J.R. Thibodeaux, R.G. Hanson, et al. 2006. "Effects of perfluorooctanoic acid exposure during pregnancy in the mouse." ***Toxicol. Sci.*** **90(2): 510–518.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Li, X., L. Ye, Y. Ge, et al. 2016. "In utero perfluorooctane sulfonate exposure causes low body weights of fetal rats: A mechanism study." ***Placenta*** **39: 125–133.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Liu, R.C.M., M.E. Hurtt, J.C. Cook, et al. 1996. "Effect of the peroxisome proliferator, ammonium perfluorooctanoate (C8), on hepatic aromatase activity in adult male Crl:CD BR (CD) rats." ***Toxicol. Sci.*** **30(2): 220–228.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Loveless, S.E., C. Finlay, N.E. Everds, et al. 2006. "Comparative responses of rats and mice exposed to linear/branched, linear, or branched ammonium perfluorooctanoate (APFO)." *Toxicology* 220: 203–217.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Ngo, H.T., R.B. Hetland, A. Sabaredzovic, et al. 2014. "In utero exposure to perfluorooctanoate (PFOA) or perfluorooctane sulfonate (PFOS) did not increase body weight or intestinal tumorigenesis in multiple intestinal neoplasia (Min/+) mice." *Environ. Res.* 132: 251–263. 10.1016/j.envres.2014.03.033.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Pastoor, T.P., K.P. Lee, M.A. Perri, et al. 1987. "Biochemical and morphological studies of ammoniumperfluorooctanoate-induced hepatomegaly and peroxisome proliferation." ***Exp. Mol. Pathol.*** **47(1): 98–109.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	
Human or primate subjects.	
In vitro studies, including cell cultures and excised tissues.	
Methods for measuring contaminants.	
Only modeling results reported.	
No viable plant or animal present or tested.	
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	
Data developed only from quantitative-structure activity relationships.	
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	
Assessment of toxicity in the field over a period of time.	
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	
The chemical form and concentration are reported.	
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	
ACCEPT/REJECT: Reject; Only one treatment level	

Reference: Permadi, H., B. Lundgren, K. Andersson, et al. 1993. "Effects of perfluoro fatty acids on peroxisome proliferation and mitochondrial size in mouse liver: Dose and time factors and effect of chain length." ***Xenobiotica*** **23(7): 761–770.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	
Human or primate subjects.	
In vitro studies, including cell cultures and excised tissues.	
Methods for measuring contaminants.	
Only modeling results reported.	
No viable plant or animal present or tested.	
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	
Data developed only from quantitative-structure activity relationships.	
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	
Assessment of toxicity in the field over a period of time.	
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	
The chemical form and concentration are reported.	
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	
ACCEPT/REJECT: Have not obtained	

Reference: Son, H., S. Kim, H.I. Shin, et al. 2008. "Perfluorooctanoic acid-induced hepatic toxicity following 21-day oral exposure in mice." ***Arch. Toxicol.*** **82: 239–246.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Staples, R.E., B.A. Burgess, W.D. Kerns. 1984. "The embryo-fetal toxicity and teratogenic potential of ammonium perfluorooctanoate (APFO) in the rat." ***Fundam. Appl. Toxicol.*** **4: 429–440.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level used.	

Reference: Vetvicka, V., J. Vetvickova. 2013. "Reversal of perfluorooctanesulfonate-induced immunotoxicity by a glucan-resverarol-vitamin C combination." ***Oriental Pharmacy and Experimental Medicine*** **13(1): 77–84.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject. Only one treatment level	

Reference: White, S.S., A.M. Calafat, Z. Kuklenyik, et al. 2007. "Gestational PFOA exposure of mice is associated with altered mammary gland development in dams and female offspring." *Toxicol. Sci.* 96(1): 133–144.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level	

Reference: White, S.S., J.P. Stanko, K. Kato, et al. 2011. "Gestational and chronic low-dose PFOA exposures and mammary gland growth and differentiation in three generations of CD-1 mice." ***Environ. Health. Perspect.*** **119(8): 1070–1076.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Wolf, C.J., S.E. Fenton, J.E. Schmid, et al. 2007. "Developmental toxicity of perfluorooctanoic acid in theCD-1 mouse after cross-foster and restricted gestational exposures." *Toxicol. Sci.* 95(2): 462–473.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Xie, Y., Q. Yang, B.D. Nelson, et al. 2003. "The relationship between liver peroxisome proliferation and adipose tissue atrophy induced by peroxisome proliferator exposure and withdrawal in mice." ***Biochem. Pharmacol.*** **66(5): 749–756.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one exposure dose	

Reference: Yahia, D., M.A. El-Nasser, M. Abedel-Latif, et al. 2010. "Effects of perfluorooctanoic acid (PFOA) exposure to pregnant mice on reproduction." ***J. Toxicol. Sci.*** **35(4): 527–533.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Yang, Q., Y. Xie, J.W. Depierre. 2000. "Effects of peroxisome proliferators on the thymus and spleen of mice." ***Clin. Exp. Immunol.*** **122(2): 219–226.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, only one exposure dose	

Reference: Yang, Q., Y. Xie, S.E. Alexson, et al. 2002. "Involvement of the peroxisome proliferator-activated receptor alpha in the immunomodulation caused by peroxisome proliferators in mice." ***Biochem. Pharmacol.*** **63(10): 1893–1900.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject, only one exposure dose	

F.4 EVALUATIONS OF STUDIES OF AQUATIC BIOTA FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFOS

Reference: Amraoui, I., N. Khalloufi, and S. Touaylia 2018. "Effects to Perfluorooctane Sulfonate (PFOS) on the Mollusk *Unio ravoisieri* Under Laboratory Exposure." *Chem. Ecol.* 34(4): 324–339.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ankley, G.T., D.W. Kuehl, M.D. Kahl, K.M. Jensen, A. Linnum, R.L. Leino, and D.A. Villeneuve. 2005. "Reproductive and Developmental Toxicity and Bioconcentration of Perfluorooctanesulfonate in a Partial Life-Cycle Test with the Fathead Minnow (*Pimephales promelas*)." *Environ. Toxicol. Chem*. 24(9): 2316–2324.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ankley, G.T., D.W. Kuehl, M.D. Kahl, K.M. Jensen, B.C. Butterworth, and J.W. Nichols. 2004. "Partial Life-Cycle Toxicity and Bioconcentration Modeling of Perfluorooctanesulfonate in the Northern Leopard Frog (*Rana pipiens*)." *Environ. Toxicol. Chem*. 23(11): 2745–2755.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Anselmo, H.M.R., L. Koerting, S. Devito, J.H.J. Van den Berg, M. Dubbeldam, C. Kwadijk, and A.J. Murk. 2011. "Early Life Developmental Effects of Marine Persistent Organic Pollutants on the Sea Urchin *Psammechinus miliaris*." *Ecotoxicol. Environ. Saf.* 74(8): 2182–2192.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because no effect reported	

Reference: Arukwe, A., M.V. Cangialosi, R.J. Letcher, E. Rocha, and A.S. Mortensen. 2013. "Changes in Morphometry and Association Between Whole-Body Fatty Acids and Steroid Hormone Profiles in Relation to Bioaccumulation Patterns in Salmon Larvae Exposed to Perfluorooctane Sulfonic or Perfluorooctane Carboxyl." *Aquat. Toxicol*. 130/131: 219–230.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; Only one treatment level used	

Reference: Bots, J., L. De Bruyn, T. Snijkers, B. Van den Branden, and H. Van Gossum. 2010. "Exposure to Perfluorooctane Sulfonic Acid (PFOS) Adversely Affects the Life-Cycle of the Damselfly *Enallagma cyathigerum*." *Environ. Pollut.* 158(3): 901–905.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<40% at end of exposure**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y, NOEC**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Boudreau, T.M., C.J. Wilson, W.J. Cheong, P.K. Sibley, S.A. Mabury, D.C.G. Muir, and K.R. Solomon. 2003a. "Response of the Zooplankton Community and Environmental Fate of Perfluorooctane Sulfonic Acid in Aquatic Microcosms." *Environ. Toxicol. Chem*. 22(11): 2739–2745.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Boudreau, T.M., P.K. Sibley, S.A. Mabury, D.G.C. Muir, and K.R. Solomon. 2003b. "Laboratory Evaluation of the Toxicity of Perfluorooctane Sulfonate (PFOS) on *Selenastrum capricornutum, Chlorella vulgaris, Lemna gibba, Daphnia magna*, and *Daphnia pulicaria*." *Arch. Environ. Contam. Toxicol*. 44(3): 307–313.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Chen, J., R.L. Tanguay, T.L. Tal, Z. Gai, X. Ma, C. Bai, S.C. Tilton, D. Jin, D. Yang, C. Huang, and Q. Dong. 2014. "Early Life Perfluorooctanesulphonic Acid (PFOS) Exposure Impairs Zebrafish Organogenesis." *Aquat. Toxicol*. 150: 124–132.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Chen, J., X. Wang, X. Ge, D. Wang, T. Wang, L. Zhang, R.L. Tanguay, M. Simonich, C. Huang, and Q. Dong. 2016. "Chronic Perfluorooctanesulphonic Acid (PFOS) Exposure Produces Estrogenic Effects in Zebrafish." ***Environ. Pollut.*** **218: 702–708.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject, only one exposure level	

Reference: Cheng, J., S. Lv, S. Nie, J. Liu, S. Tong, N. Kang, Y. Xiao, Q. Dong, C. Huang, and D. Yang. 2016. "Chronic Perfluorooctane Sulfonate (PFOS) Exposure Induces Hepatic Steatosis in Zebrafish." ***Aquat. Toxicol.*** **176: 45–52.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject: Only one treatment level used	

Reference: Cheng, Y., Y. Cui, H.M. Chen, and W.P. Xie. 2011. "Thyroid Disruption Effects of Environmental Level Perfluorooctane Sulfonates (PFOS) in *Xenopus laevis*." *Ecotoxicology* 20(8): 2069–2078.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**72%**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because no effect reported for an ecologically relevant endpoint	

Reference: Cui, Y., S. Lv, J. Liu, S. Nie, J. Chen, Q. Dong, C. Huang, and D. Yang. 2017. "Chronic Perfluorooctanesulfonic Acid Exposure Disrupts Lipid Metabolism in Zebrafish." ***Hum. Exp. Toxicol.*** **36(3): 207–217.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Dang, Y., F. Wang, and C. Liu. 2018. "Real-Time PCR Array to Study the Effects of Chemicals on the Growth Hormone/Insulin-Like Growth Factors (GH/IGFs) Axis of Zebrafish Embryos/Larvae." *Chemosphere* 207: 365–376.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**NN**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Desjardins, D., C.A. Sutherland, R.L. Van Hoven, and H.O. Krueger. 2001. *PFOS: A 96-Hour Toxicity Test with the Marine Diatom (*Skeletonema costatum*)*. Project 454-A-113A, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not measured**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject, only one treatment level used	

Reference: Ding, G., J. Zhang, Y. Chen, L. Wang, M. Wang, D. Xiong, and Y. Sun. 2013. "Combined Effects of PFOS and PFOA on Zebrafish (*Danio rerio*) Embryos." *Arch. Environ. Contam. Toxicol.* 64(4): 668–675.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Dorts, J., P. Kestemont, P.A. Marchand, W. D'Hollander, M.L. Thezenas, M. Raes, and F. Silvestre. 2011. "Ecotoxicoproteomics in Gills of the Sentinel Fish Species, *Cottus gobio*, Exposed to Perfluorooctane Sulfonate (PFOS)." *Aquat. Toxicol.* 103(1/2): 1–8.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects on ecologically relevant endpoints reported	

Reference: Drottar, K.R., and H.O. Krueger. 2000. *PFOS: An Early Life-Stage Test with the Fathead Minnow (*Pimephales promelas*). Project 454A-108, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000. *PFOS: A 96-Hour Shell Deposition Test with the Eastern Oyster (*Crassostrea virginica*). Project 454A-106, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000. *PFOS: A Flow-Through Life-Cycle Toxicity Test with the Saltwater Mysid (*Mysidopsis bahia*). Project 454-A-107, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000. *PFOS: A 96-Hour Static Acute Toxicity Test with the Saltwater Mysid (*Mysidopsis bahia*). Project 454-A-107, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000a. *PFOS: A 48-Hour Static Acute Toxicity Test with the Cladoceran (*Daphnia magna*)*. Project 454-A-104, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000b. *PFOS: A Semi-Static Life-Cycle Toxicity Test with the Cladoceran (*Daphnia magna*)*. Project 454-A-109, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000. *PFOS: A 96-Hour Toxicity Test with the Freshwater Alga (*Selenastrum capricornutum*). Project 454-A-103A, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., and H.O. Krueger. 2000. *PFOS: A 96-Hour Static Acute Toxicity Test with the Freshwater Mussel (*Unio complamatus*).* Project 454-A-105, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Drottar, K.R., R.L. VanHoven, and H.O. Krueger. 2001. *Perfluorooctanesulfonate, Potassium Salt (PFOS): A Flow-Through Bioconcentration Test with the Bluegill (*Lepomis macrochirus*). Project 454A-134, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Du, J., S. Wang, H. You, and Z. Liu. 2016a. "Effects of ZnO Nanoparticles on Perfluorooctane Sulfonate Induced Thyroid-Disrupting on Zebrafish Larvae." *J. Environ. Sci.* 47: 153–164.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**25% control mortality**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Du, J., S. Wang, H. You, R. Jiang, C. Zhuang, and X. Zhang. 2016b. "Developmental Toxicity and DNA Damage to Zebrafish Induced by Perfluorooctane Sulfonate in the Presence of ZnO Nanoparticles." *Environ. Toxicol.* 31(3): 360–371.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Du, Y., X. Shi, C. Liu, K. Yu, and B. Zhou. 2009. "Chronic Effects of Water-Borne PFOS Exposure on Growth, Survival and Hepatotoxicity in Zebrafish: A Partial Life-Cycle Test." *Chemosphere* 74(5): 723–729.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Fabbri, R., M. Montagna, T. Balbi, E. Raffo, F. Palumbo, and L. Canesi. 2014. "Adaptation of the Bivalve Embryotoxicity Assay for the High Throughput Screening of Emerging Contaminants in *Mytilus galloprovincialis*." *Mar. Environ. Res.* 99: 1–8.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Fang, C., L. Qiu, X. Wu, Q. Huang, Y. Liao, L. Liu, H. Shen, and S. Dong. 2012. "PFOS Elicits Transcriptional Responses of the ER, AHR and PPAR Pathways in *Oryzias melastigma* in a Stage-Specific Manner." *Aquat. Toxicol.* 106/107: 9–19.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Feng, M., Q. He, L. Meng, X. Zhang, P. Sun, and Z. Wang. 2015. "Evaluation of Single and Joint Toxicity of Perfluorooctane Sulfonate, Perfluorooctanoic Acid, and Copper to *Carassius auratus* Using Oxidative Stress Biomarkers." *Aquat. Toxicol.* 161: 108–116.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect reported on ecologically relevant endpoint	

Reference: Gunduz, G., H. Parlak, O.C. Arslan, M. Boyacioglu, and M.A. Karaaslan. 2013. "Embryotoxic Effects of Perfluorooctane Sulfonate Compounds in Sea Urchin *Paracentrotus lividus*." *Fresenius Environ. Bull.* 22(1a): 171–177.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hagenaars, A., D. Knapen, I.J. Meyer, K. Van der Ven, P. Hoff, and W. De Coen. 2008. "Toxicity Evaluation of Perfluorooctane Sulfonate (PFOS) in the Liver of Common Carp (*Cyprinus carpio*)." *Aquat. Toxicol.* 88(3): 155–163.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hagenaars, A., I.J. Meyer, D. Herzke, B.G. Pardo, P. Martinez, M. Pabon, W. De Coen, and D. Knapen. 2011. "The Search for Alternative Aqueous Film Forming Foams (AFFF) with a Low Environmental Impact: Physiological and Transcriptomic Effects of Two Forafac Fluorosurfactants in Turbot." *Aquat. Toxicol.* 104(3/4): 168–176.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only on treatment level used	

Reference: Hagenaars, A., L. Vergauwen, W. De Coen, and D. Knapen. 2011. "Structure-Activity Relationship Assessment of Four Perfluorinated Chemicals Using a Prolonged Zebrafish Early Life Stage Test." *Chemosphere* 82:764–772.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hagenaars, A., E. Stinckens, L. Vergauwen, L. Bervoets, and D. Knapen. 2014. "PFOS Affects Posterior Swim Bladder Chamber Inflation and Swimming Performance of Zebrafish Larvae." *Aquat. Toxicol*. 157: 225–235.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Han, J., and Z. Fang. 2010. "Estrogenic Effects, Reproductive Impairment and Developmental Toxicity in Ovoviparous Swordtail Fish (*Xiphophorus helleri*) Exposed to Perfluorooctane Sulfonate (PFOS)." *Aquat. Toxicol.* 99(2): 281–290.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Han, J., E.J. Won, M.C. Lee, J.S. Seo, S.J. Lee, and J.S. Lee. 2015. "Developmental Retardation, Reduced Fecundity, and Modulated Expression of the Defensome in the Intertidal Copepod *Tigriopus japonicus* Exposed to BDE-47 and PFOS." *Aquat. Toxicol.* 165: 136–143.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hanson, M.L., P.K. Sibley, R.A. Brain, S.A. Mabury, and K.R. Solomon. 2005. "Microcosm Evaluation of the Toxicity and Risk to Aquatic Macrophytes from Perfluorooctane Sulfonic Acid." *Arch. Environ. Contam. Toxicol.* 48(3): 329–337.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hazelton, P.D., W.G. Cope, T.J. Pandolfo, S. Mosher, M.J. Strynar, M.C. Barnhart, and R.B. Bringolf. 2012. "Partial Life-Cycle and Acute Toxicity of Perfluoroalkyl Acids to Freshwater Mussels." *Environ. Toxicol. Chem*. 31(7): 1611–1620.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hoover, G.M., M.F. Chislock, B.J. Tornabene, S.C. Guffey, Y.J. Choi, C. De Perre, J.T. Hoverman, L.S. Lee, and M.S. Sepu. 2017. "Uptake and Depuration of Four Per/Polyfluoroalkyl Substances (PFASs) in Northern Leopard Frog *Rana pipiens* Tadpoles." *Environ. Sci. Technol. Lett.* 4(10): 399–403.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Huang, H., C. Huang, L. Wang, X. Ye, C. Bai, M.T. Simonich, R.L. Tanguay, and Q. Dong. 2010. "Toxicity, Uptake Kinetics and Behavior Assessment in Zebrafish Embryos Following Exposure to Perfluorooctanesulphonicacid (PFOS)." *Aquat. Toxicol*. 98(2): 139–147.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Huang, Q., C. Fang, X. Wu, J. Fan, and S. Dong. 2011. "Perfluorooctane Sulfonate Impairs the Cardiac Development of a Marine Medaka (*Oryzias melastigma*)." *Aquat. Toxicol.* 105(1/2): 71–77.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no ecologically relevant endpoint was assessed	

Reference: Huang, Q., Y. Chen, Y. Chi, Y. Lin, H. Zhang, C. Fang, and S. Dong. 2015. "Immunotoxic Effects of Perfluorooctane Sulfonate and Di(2-Ethylhexyl) Phthalate on the Marine Fish *Oryzias melastigma*." *Fish Shellfish Immunol*. 44(1): 302–306.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**y**
Study used a control(s).	**y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Organ weight in relation to body weight. Not sure this is ecologically significant	

Reference: Huang, S.S.Y., J.P. Benskin, B. Chandramouli, H. Butler, C.C. Helbing, and J.R. Cosgrove. 2016. "Xenobiotics Produce Distinct Metabolomic Responses in Zebrafish Larvae (*Danio rerio*)." *Environ. Sci. Technol.* 50(12): 6526–6535.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effects reported	

Reference: Inoue, Y., N. Hashizume, N. Yakata, H. Murakami, Y. Suzuki, E. Kikushima, and M. Otsuka. 2012. "Unique Physicochemical Properties of Perfluorinated Compounds and Their Bioconcentration in Common Carp *Cyprinus carpio* L." *Arch. Environ. Contam. Toxicol.* 62(4): 672–680.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no ecologically significant effect reported	

Reference: Jacobson, T., K. Holmstrom, G. Yang, A.T. Ford, U. Berger, and B. Sundelin. 2010. "Perfluorooctane Sulfonate Accumulation and Parasite Infestation in a Field Population of the Amphipod *Monoporeia affinis* After Microcosm Exposure." *Aquat. Toxicol.* 98(1): 99–106.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**n**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y but nominal or measured were quite different**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Jantzen, C.E., K.A. Annunziato, S.M. Bugel, and K.R. Cooper. 2016a. "PFOS, PFNA, and PFOA Sub-Lethal Exposure to Embryonic Zebrafish have Different Toxicity Profiles in Terms of Morphometrics, Behavior and Gene Expression." *Aquat. Toxicol.* 175: 160–170.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20% for all tx**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Jantzen, C.E., K.A. Annunziato, S.M. Bugel, and K.R. Cooper. 2016b. "Behavioral, morphometric, and gene expression effects in adult zebrafish (*Danio rerio*) embryonically exposed to PFOA, PFOS, and PFNA." *Aquat. Toxicol.* 180: 123–130.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20% for all tx**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only 1 treatment level	

Reference: Jeon, J., H.K. Lim, K. Kannan, and S.D. Kim. 2010b. "Effect of Perfluorooctanesulfonate on Osmoregulation in Marine Fish, *Sebastes schlegeli*, Under Different Salinities." *Chemosphere* 81(2): 228–234.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects to growth, mortality or reproduction reported	

Reference: Jeon, J., K. Kannan, H.K. Lim, H.B. Moon, J.S. Ra, and S.D. Kim. 2010. "Bioaccumulation of Perfluorochemicals in Pacific Oyster Under Different Salinity Gradients." *Environ. Sci. Technol.* 44(7): 2695–2701.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects to growth, mortality or reproduction reported	

Reference: Jeong, T.Y., M.S. Yuk, J. Jeon, and S.D. Kim. 2016. "Multigenerational Effect of Perfluorooctane Sulfonate (PFOS) on the Individual Fitness and Population Growth of Daphnia magna." *Sci. Total Environ*. 569/570: 1553–1560.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ji, K., Y. Kim, S. Oh, B. Ahn, H. Jo, and K. Choi. 2008. "Toxicity of Perfluorooctane Sulfonic Acid and Perfluorooctanoic Acid on Freshwater Macroinvertebrates (*Daphnia magna* and *Moina macrocopa*) and Fish (*Oryzias latipes*)." *Environ. Toxicol. Chem*. 27(10): 2159–2168.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Keiter, S., K. Burkhardt-Medicke, P. Wellner, B. Kais, H. Farber, D. Skutlarek, M. Engwall, T. Braunbeck, S.H. Keiter. 2016. "Does Perfluorooctane Sulfonate (PFOS) Act as Chemosensitizer in Zebrafish Embryos?" *Sci. Total Environ*. 548/549: 317–324.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject. A mixture was used with only one PFOS tx level	

Reference: Keiter, S., L. Baumann, H. Farber, H. Holbech, D. Skutlarek, M. Engwall, and T. Braunbeck. 2012. "Long-Term Effects of a Binary Mixture of Perfluorooctane Sulfonate (PFOS) and Bisphenol A (BPA) in Zebrafish (*Danio rerio*)." *Aquat. Toxicol*. 118/119: 116–129.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Kim, W.K., S.K. Lee, and J. Jung. 2010. "Integrated Assessment of Biomarker Responses in Common Carp (*Cyprinus carpio*) Exposed to Perfluorinated Organic Compounds." *J. Hazard. Mater*. 180(1-3): 395–400.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effect on ecologically relevant endpoint	

Reference: Kim, S., K. Ji, S. Lee, J. Lee, J. Kim, S. Kim, Y. Kho, and K. Choi. 2011. "Perfluorooctane Sulfonic Acid Exposure Increases Cadmium Toxicity in Early Life Stage of Zebrafish, *Danio rerio*." *Environ. Toxicol. Chem*. 30(4): 870–877.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only 1 treatment level	

Reference: Li, M.H. 2008. "Effects of Nonionic and Ionic Surfactants on Survival, Oxidative Stress, and Cholinesterase Activity of Planarian." *Chemosphere* 70(10): 1796–1803.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2009. "Toxicity of Perfluorooctane Sulfonate and Perfluorooctanoic Acid to Plants and Aquatic Invertebrates." ***Environ. Toxicol.*** **24(1): 95–101.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2010. "Chronic Effects of Perfluorooctane Sulfonate and Ammonium Perfluorooctanoate on Biochemical Parameters, Survival and Reproduction of *Daphnia magna*." *J. Health Sci*. 56(1): 104–111.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Li, M.H. 2011. "Changes of Cholinesterase and Carboxylesterase Activities in Male Guppies, *Poecilia reticulate*, After Exposure to Ammonium Perfluorooctanoate, but not to Perfluorooctane Sulfonate." *Fresenius Environ. Bull.* 20(8a): 2065–2070.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects on ecologically relevant endpoints reported	

Reference: Liang, R., J. He, Y. Shi, Z. Li, S. Sarvajayakesavalu, Y. Baninla, F. Guo, J. Chen, X. Xu, and Y. Lu. 2017. "Effects of Perfluorooctane Sulfonate on Immobilization, Heartbeat, Reproductive and Biochemical Performance of *Daphnia magna*." *Chemosphere* 168: 1613–1618.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, W., S. Chen, X. Quan, and Y.H. Jin. 2008. "Toxic Effect of Serial Perfluorosulfonic and Perfluorocarboxylic Acids on the Membrane System of a Freshwater Alga Measured by Flow Cytometry." *Environ. Toxicol. Chem*. 27(7): 1597–1604.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, W., Y.B. Zhang, X. Quan, Y.H. Jin, and S. Chen. 2009. "Effect of Perfluorooctane Sulfonate on Toxicity and Cell Uptake of Other Compounds with Different Hydrophobicity in Green Alga." *Chemosphere* 75(3): 405–409.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect of PFOS found	

Reference: Liu, C., Q. Wang, K. Liang, J. Liu, B. Zhou, X. Zhang, H. Liu, J.P. Giesy, and H. Yu. 2013. "Effects of Tris(1,3-Dichloro-2-Propyl) Phosphate and Triphenyl Phosphate on Receptor-Associated mRNA Expression in Zebrafish Embryos/Larvae." ***Aquat. Toxicol.*** **128: 147–157.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one treatment level used	

Reference: Liu, C., K.Y.H. Gin, and V.W.C. Chang. 2014. "Multi-Biomarker Responses in Green Mussels Exposed to PFCs: Effects at Molecular, Cellular, and Physiological Levels." ***Environ. Sci. Pollut. Res.*** **21: 2785–2794.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, J., R. Qu, L. Yan, L. Wang, and Z. Wang. 2016. "Evaluation of Single and Joint Toxicity of Perfluorooctane Sulfonate and Zinc to *Limnodrilus hoffmeisteri*: Acute Toxicity, Bioaccumulation and Oxidative Stress." *J. Hazard. Mater*. 301: 342–349.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept; need to get supplemental data to see PFOS results	

Reference: Lou, Q.Q., Y.F. Zhang, Z. Zhou, Y.L. Shi, Y.N. Ge, D.K. Ren, H.M. Xu, Y.X. Zhao, W.J. Wei, and Z.F. Qin. 2013. "Effects of Perfluorooctanesulfonate and Perfluorobutanesulfonate on the Growth and Sexual Development of *Xenopus laevis*." *Ecotoxicology* 22(7): 1133–1144.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect on growth mortality or reproduction	

Reference: Lu, G., J. Liu, L. Sun, and L. Yuan. 2015. "Toxicity of Perfluorononanoic Acid and Perfluorooctane Sulfonate to *Daphnia magna*." *Water Sci. Eng*. 8(1): 40–48.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: MacDonald, M.M., A.L. Warne, N.L. Stock, S.A. Mabury, K.R. Solomon, and P.K. Sibley. 2004. "Toxicity of Perfluorooctane Sulfonic Acid and Perfluorooctanoic Acid to *Chironomus tentans*." *Environ. Toxicol. Chem*. 23(9): 2116–2123.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Marziali, L., F. Rosignoli, S. Valsecchi, S. Polesello, and F. Stefani. 2019. "Effects of Perfluoralkyl Substances (PFASs) on a Multigenerational Scale: A Case Study with *Chironomus riparius* (Diptera, Chironomidae)." *Environ. Toxicol. Chem*. 38 No. 5: 988-999.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because only one treatment level was used for PFOS	

Reference: Matsubara, E., K. Harada, K. Inoue, and A. Koizumi. 2006. "Effects of Perfluorinated Amphiphiles on Backward Swimming in *Paramecium caudatum*." *Biochem. Biophys. Res. Commun*. 339(2): 554–561.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**Y**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; studies cells	

Reference: Meng, L., S. Yang, M. Feng, R. Qu, Y. Li, J. Liu, Z. Wang, and C. Sun. 2016. "Toxicity and Bioaccumulation of Copper in *Limnodrilus hoffmeisteri* Under Different pH Values: Impacts of Perfluorooctane Sulfonate." *J. Hazard. Mater*. 305: 219–228.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; one treatment level used	

Reference: Menger, F., J. Pohl, L. Ahrens, G. Carlsson, S. Orn. 2020. "Behavioural effects and bioconcentration of per- and polyfluoroalkyl substances (PFASs) in zebrafish (*Danio rerio*) embryos." *Chemosphere* 245: 125573.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Mhadhbi, L., D. Rial, S. Perez, and R. Beiras. 2012. "Ecological Risk Assessment of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) in Marine Environment Using *Isochrysis galbana, Paracentrotus lividus, Siriella armata* and *Psetta maxima*." *J. Environ. Monit.* 14(5): 1375–1382.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Mortensen, A.S., R.J. Letcher, M.V. Cangialosi, S. Chu, and A. Arukwe. 2011. "Tissue Bioaccumulation Patterns, Xenobiotic Biotransformation and Steroid Hormone Levels in Atlantic Salmon (*Salmo salar*) Fed a Diet Containing Perfluorooctane Sulfonic or Perfluorooctane Carboxylic Acids." *Chemosphere* 83(8): 1035–1044.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Food**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; one treatment level used; administered as food; and no effect reported	

Reference: Oakes, K.D., P.K. Sibley, J.W. Martin, D.D. MacLean, K.R. Solomon, S.A. Mabury, and G.J. Van der Kraak. 2005. "Short-Term Exposures of Fish to Perfluorooctane Sulfonate: Acute Effects on Fatty Acyl-CoA Oxidase Activity, Oxidative Stress, and Circulating Sex Steroids." *Environ. Toxicol. Chem*. 24(5): 1172–1181.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Oh, J.H., H.B. Moon, and E.S. Choe. 2013. "Alterations in Differentially Expressed Genes After Repeated Exposure to Perfluorooctanoate and Perfluorooctanesulfonate in Liver of *Oryzias latipes*." *Arch. Environ. Contam. Toxicol*. 64(3): 475–483.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect was found	

Reference: Palmer, S.J., and H.O. Krueger. 2001. *PFOS: A Frog Embryo Teratogenesis Assay - Xenopus (FETAX)*. Project 454A-116, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Park, K., C. Nikapitiya, T.S. Kwak, and I.S. Kwak. 2015. "Antioxidative-Related Genes Expression Following Perfluorooctane Sulfonate (PFOS) Exposure in the Intertidal Mud Crab, *Macrophthalmus japonicus*." *Ocean Sci. J.* 50(3): 547–556.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Preus-Olsen, G., M.O. Olufsen, S.A. Pedersen, R.J. Letcher, and A. Arukwe. 2014. "Effects of Elevated Dissolved Carbon Dioxide and Perfluorooctane Sulfonic Acid, Given Singly and in Combination, on Steroidogenic and Biotransformation Pathways of Atlantic Cod." ***Aquat. Toxicol*****. 155: 222–235.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effect described	

Reference: Qiang, L., X. Shi, X. Pan, L. Zhu, M. Chen, and Y. Han. 2015. "Facilitated Bioaccumulation of Perfluorooctanesulfonate in Zebrafish by Nano-TiO2 in Two Crystalline Phases." *Environ. Pollut.* 206: 644–651.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no observed effect and only one treatment level	

Reference: Qiang, L., M. Chen, L. Zhu, W. Wu, and Q. Wang. 2016a. "Facilitated Bioaccumulation of Perfluorooctanesulfonate in Common Carp (*Cyprinus carpio*) by Graphene Oxide and Remission Mechanism of Fulvic Acid." *Environ. Sci. Technol.* 50(21): 11627–11636.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one treatment level was used; no effect reported	

Reference: Qiang, L., X. Pan, L. Zhu, S. Fang, and S. Tian. 2016b. "Effects of Nano-TiO2 on Perfluorooctanesulfonate Bioaccumulation in Fishes Living in Different Water Layers: Implications for Enhanced Risk of Perfluorooctanesulfonate." *Nanotoxicology* 10(4): 471–479.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject. No effects on ecologically relevant endpoints reported	

Reference: Qu, R., J. Liu, L. Wang, and Z. Wang. 2016. "The Toxic Effect and Bioaccumulation in Aquatic Oligochaete *Limnodrilus hoffmeisteri* After Combined Exposure to Cadmium and Perfluorooctane Sulfonate at Different pH Values." *Chemosphere* 152: 496–502.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Rodea-Palomares, I., M. Makowski, S. Gonzalo, M. Gonzalez-Pleiter, F. Leganes, and F. Fernandez-Pinas. 2016. "Effect of PFOA/PFOS Pre-Exposure on the Toxicity of the Herbicides 2,4-D, Atrazine, Diuron and Paraquat to a Model Aquatic Photosynthetic Microorganism." *Chemosphere* 139: 65–72.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; endpoint was bioluminescence	

Reference: Roland, K., P. Kestemont, R. Loos, S. Tavazzi, B. Paracchini, C. Belpaire, M. Dieu, M. Raes, and F. Silvestre. 2014. "Looking for Protein Expression Signatures in European Eel Peripheral Blood Mononuclear Cells After In Vivo Exposure to Perfluorooctane Sulfonate and a Real World Field Study." *Sci. Total Environ*. 468/469: 958–967.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect reported	

Reference: Rosal, R., I. Rodea-Palomares, K. Boltes, F. Fernandez-Pinas, F. Leganes, and A. Petre. 2010. "Ecotoxicological Assessment of Surfactants in the Aquatic Environment: Combined Toxicity of Docusate Sodium with Chlorinated Pollutants." *Chemosphere* 81(2): 288–293.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sakurai, T., J. Kobayashi, N. Ito, S. Serizawa, H. Shiraishi, T. Yabe, Y. Ishii, and N. Suzuki. 2017. "Respiratory Uptake and Depuration Kinetics of Perfluorooctanesulfonate (PFOS) in a Marine Sandworm Species." ***Bull. Environ. Contam. Toxicol.*** **99(2): 203–207.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Measured**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one treatment level used; no effect found	

Reference: Sanderson, H., T.M. Boudreau, S.A. Mabury, W.J. Cheong, and K.R. Solomon. 2002. "Ecological Impact and Environmental Fate of Perfluorooctane Sulfonate on the Zooplankton Community in Indoor Microcosms." *Environ. Toxicol. Chem*. 21(7): 1490–1496.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sanderson, H., T.M. Boudreau, S.A. Mabury, and K.R. Solomon. 2004. "Effects of Perfluorooctane Sulfonate and Perfluorooctanoic Acid on the Zooplanktonic Community." *Ecotoxicol. Environ. Saf.* 58(1): 68–76.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: San-Segundo, L., L. Guimaraes, C.F. Torija, E.M. Beltran, L. Guilhermino, and M.V. Pablos. 2016. "Alterations in Gene Expression Levels Provide Early Indicators of Chemical Stress During Xenopus laevis Embryo Development: a Case Study with Perfluorooctane Sulfonate (PFOS)." *Ecotoxicol. Environ. Saf.* 127: 51–60.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sant, K.E., H.M. Jacobs, K.A. Borofski, J.B. Moss, and A.R. Timme-Laragy. 2017. "Embryonic Exposures to Perfluorooctanesulfonic Acid (PFOS) Disrupt Pancreatic Organogenesis in the Zebrafish, *Danio rerio*." *Environ. Pollut.* 220: 807–817.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sant, K.E., P.P. Sinno, H.M. Jacobs, and A.R. Timme-Laragy. 2018. "Nrf2a Modulates the Embryonic Antioxidant Response to Perfluorooctanesulfonic Acid (PFOS) in the Zebrafish, *Danio rerio*." *Aquat. Toxicol.* 198: 92–102.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sharpe, R.L., J.P. Benskin, A.H. Laarman, S.L. MacLeod, J.W. Martin, C.S. Wong, and G.G. Goss. 2010. "Perfluorooctane Sulfonate Toxicity, Isomer-Specific Accumulation, and Maternal Transfer in Zebrafish (*Danio rerio*) and Rainbow Trout (*Oncorhynchus mykiss*)." *Environ. Toxicol. Chem*. 29(9): 1957–1966.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Shi, X., Y. Du, P.K.S. Lam, R.S.S. Wu, and B. Zhou. 2008. "Developmental Toxicity and Alteration of Gene Expression in Zebrafish Embryos Exposed to PFOS." *Toxicol. Appl. Pharmacol.* 230(1): 23–32.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<25%**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Shi, X., C. Liu, G. Wu, and B. Zhou. 2009a. "Waterborne Exposure to PFOS Causes Disruption of the Hypothalamus-Pituitary-Thyroid Axis in Zebrafish Larvae." *Chemosphere* 77(7): 1010–1018.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<25%**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Shi, X., L.W.Y. Yeung, P.K.S. Lam, R.S.S. Wu, and B. Zhou. 2009. "Protein Profiles in Zebrafish (*Danio rerio*) Embryos Exposed to Perfluorooctane Sulfonate." *Toxicol. Sci.* 110(2): 334–340.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject. Only 1 treatment level	

Reference: Spachmo, B., and A. Arukwe. 2012. "Endocrine and Developmental Effects in Atlantic Salmon (*Salmo salar*) Exposed to Perfluorooctane Sulfonic or Perfluorooctane Carboxylic Acids." *Aquat. Toxicol.* 108: 112–124.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one treatment level used	

Reference: Stefani, F., M. Rusconi, S. Valsecchi, and L. Marziali. 2014. "Evolutionary Ecotoxicology of Perfluoralkyl Substances (PFASs) Inferred from Multigenerational Exposure: A Case Study with *Chironomus riparius* (Diptera, Chironomidae)." *Aquat. Toxicol.* 156: 41–51.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because only one treatment level used	

Reference: Stengel, D., F. Zindler, and T. Braunbeck. 2017b. "An Optimized Method to Assess Ototoxic Effects in the Lateral Line of Zebrafish (*Danio rerio*) Embryos." *Comp. Biochem. Physiol. C Toxicol. Pharmacol.* 193: 18–29.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Sutherland, C.A., and H.O. Krueger. 2001. *PFOS: A 96-Hour Toxicity Test with the Freshwater Diatom (*Navicula pelliculosa*)*. Project 454A-112, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ulhaq, M., G. Carlsson, S. Orn, and L. Norrgren. 2013. "Comparison of Developmental Toxicity of Seven Perfluoroalkyl Acids to Zebrafish Embryos." *Environ. Toxicol. Pharmacol.* 36: 423–426.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Van Gossum, H., J. Bots, T. Snijkers, J. Meyer, S.V. Wassenbergh, W.D. Coen, and L. De Bruyn. 2009. "Behavior of Damselfly Larvae (*Enallagma cyathigerum*) (Insecta, Odonata) After Long-Term Exposure to PFOS." *Environ. Pollut.* 157(4): 1332–1336.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No endpoint reported statistically	

Reference: Wagner, N.D., A.J. Simpson, and M.J. Simpson. 2016. "Metabolomic Responses to Sublethal Contaminant Exposure in Neonate and Adult *Daphnia magna*." *Environ. Toxicol. Chem*. 36(4): 938–946.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one treatment used	

Reference: Wang, M., J. Chen, K. Lin, Y. Chen, W. Hu, R.L. Tanguay, C. Huang, and Q. Dong. 2011. "Chronic Zebrafish PFOS Exposure Alters Sex Ratio and Maternal Related Effects in F1 Offspring." ***Environ. Toxicol. Chem*****. 30(9): 2073–2080.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Wang, S., C. Zhuang, J. Du, C. Wu, and H. You. 2017. "The Presence of MWCNTs Reduces Developmental Toxicity of PFOS in Early Life Stage of Zebrafish." *Environmental Pollution* 222: 201–209.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**~20%**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Wu, X., Q. Huang, C. Fang, T. Ye, L. Qiu, and S. Dong. 2012. "PFOs Induced Precocious Hatching of *Oryzias melastigma* - from Molecular Level to Individual Level." *Chemosphere* 87(7): 703–708.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20%**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Xia, J., and C. Niu. 2017. "Acute Toxicity Effects of Perfluorooctane Sulfonate on Sperm Vitality, Kinematics and Fertilization Success in Zebrafish." *Chin. J. Oceanol. Limnol.* 35(4): 723–728.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Xia, J.G., L.J. Nie, X.M. Mi, W.Z. Wang, Y.J. Ma, Z.D. Cao, and S.J. Fu. 2015. "Behavior, Metabolism and Swimming Physiology in Juvenile *Spinibarbus sinensis* Exposed to PFOS Under Different Temperatures." *Fish Physiol. Biochem*. 41(5): 1293–1304.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect reported on relevant endpoint	

Reference: Yang, S., F. Xu, F. Wu, S. Wang, and B. Zheng. 2014. "Development of PFOS and PFOA Criteria for the Protection of Freshwater Aquatic Life in China." *Sci. Total Environ*. 470/471: 677–683.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Yuan, Z., J. Zhang, W. Meng, and Y. Zhou. 2014b. "Effects of Perfluorooctane Sulfonate on Behavioural Activity, Regeneration and Antioxidant Enzymes in Planarian *Dugesia japonica*." *Chem. Ecol*. 30(2): 187–195.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Yuan, Z., X. Shao, Z. Miao, B. Zhao, Z. Zheng, and J. Zhang. 2018. "Perfluorooctane Sulfonate Induced Neurotoxicity Responses Associated with Neural Genes Expression, Neurotransmitter Levels and Acetylcholinesterase Activity in Planarians *Dugesia japonica*." *Chemosphere* 206: 150–156.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect on ecologically relevant endpoint was found	

Reference: Zhai, Y., X. Xia, X. Zhao, H. Dong, B. Zhu, N. Xia, and J. Dong. 2016. "Role of Ingestion Route in the Perfluoroalkyl Substance Bioaccumulation by *Chironomus plumosus* Larvae in Sediments Amended with Carbonaceous Materials." *J. Hazard. Mater*. 302: 404–414.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; No effect detected on ecologically relevant endpoint and only 1 treatment level used	

Reference: Zhang, L., J. Niu, Y. Li, Y. Wang, and D. Sun. 2013. "Evaluating the Sub-Lethal Toxicity of PFOS and PFOA Using Rotifer *Brachionus calyciflorus*." *Environ. Pollut.* 180: 34–40.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhang, L., J. Niu, Y. Wang, J. Shi, and Q. Huang. 2014. "Chronic Effects of PFOA and PFOS on Sexual Reproduction of Freshwater Rotifer *Brachionus calyciflorus*." *Chemosphere* 114: 114–120.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhang, L., Y.Y. Li, H.C. Zeng, J. Wei, Y.J. Wan, J. Chen, and S.Q. Xu. 2011. "MicroRNA Expression Changes During Zebrafish Development Induced by Perfluorooctane Sulfonate." *J. Appl. Toxicol*. 31(3): 210–222.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only 1 treatment level used	

Reference: Zheng, X.M., H.L. Liu, W. Shi, S. Wei, J.P. Giesy, and H.X. Yu. 2012. "Effects of Perfluorinated Compounds on Development of Zebrafish Embryos." *Environ. Sci. Pollut. Res.* 19(7): 2498–2505.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.5 EVALUATIONS OF STUDIES OF TERRESTRIAL SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFOS

Reference: 3M Co. 2001. Support: Ltr Fr 3M to USEPA Submitting 2 Acute Toxicity Studies in Honeybees with Perfluorooctanesulfonate, Potassium Salt (Nos. AR226_1017 & AR226_1018), W/Attchmnt & Dtd 050101. EPA/OTS:16 p. (See "Wilkins, P. 2001. Study Number HT5602 Perflurooctanesolfonate, Potassium salt (PFOS):an acute oral toxicity study with the honey bee. Report amendment No. 1"	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Brignole, A.J., J.R. Porch, H.O. Krueger, and R.L. Van Hoven. 2003. *PFOS: A Toxicity Test to Determine the Effects of the Test Substance on Seedling Emergence of Seven Species of Plants*. EPA Docket AR226-1369, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Gadelhak, G.G. 1993. *Novel Pesticides Affecting Mitochondrial Functions*. Ph.D. Thesis, Michigan State University, East Lansing, MI.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Gallagher, S.P., R.L. Van Hoven, J.B. Beavers, and M. Jaber. 2003a. *PFOS: A Reproduction Study with the Northern Bobwhite.* Final Report. Project 454-108, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Gallagher, S.P., R.L. Van Hoven, J.B. Beavers, and M. Jaber. 2003b. *PFOS: A Reproduction Study with the Mallard.* Final Report. Project 454-109, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Hu, W., P.D. Jones, B.L. Upham, J.E. Trosko, C. Lau, and J.P. Giesy. 2002. "Inhibition of Gap Junctional Intercellular Communication by Perfluorinated Compounds in Rat Liver and Dolphin Kidney Epithelial Cell Lines In Vitro and Sprague-Dawley Rats In Vivo." ***Toxicol. Sci.*** **68(2): 429–436.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	
ACCEPT/REJECT: Reject, only 1 treatment level used for live exposure	

Reference: Martin, M.T., R.J. Brennan, W. Hu, E. Ayanoglu, et al. 2007. "Toxicogenomic Study of Triazole Fungicides and Perfluoroalkyl Acids in Rat Livers Predicts Toxicity and Categorizes Chemicals Based on Mechanisms of Toxicity." ***Toxicol. Sci.*** **97(2): 595–613.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; no effect on weight gain reported for PFOS; only one treatment level used	

Reference: Mommaerts, V., A. Hagenaars, J. Meyer, W. De Coen, L. Swevers, H. Mosallanejad, and G. Smagghe 2011. "Impact of a Perfluorinated Organic Compound PFOS on the Terrestrial Pollinator *Bombus terrestris* (Insecta, Hymenoptera)." *Ecotoxicology* 20(2): 447–456.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Newsted, J.L., K.K. Coady, S.A. Beach, J.L. Butenhoff, S. Gallagher, and J.P. Giesy. 2007. "Effects of Perfluorooctane Sulfonate on Mallard and Northern Bobwhite Quail Exposed Chronically via the Diet." ***Environ. Toxicol. Pharmacol.*** **23(1): 1–9.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Newsted, J.L., S.A. Beach, S.P. Gallagher, and J.P. Giesy. 2006. "Pharmacokinetics and Acute Lethality of Perfluorooctanesulfonate (PFOS) to Juvenile Mallard and Northern Bobwhite." *Arch. Environ. Contam. Toxicol.* 50(3): 411–420.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Princz, J., M. Jatar, H. Lemieux, and R. Scroggins. 2018. "Perfluorooctane Sulfonate in Surface Soils: Effects on Reproduction in the Collembolan, *Folsomia candida*, and the Oribatid Mite, *Oppia nitens*." *Chemosphere* 208: 757–763.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Rogers, J.M., R.G. Ellis-Hutchings, B.E. Grey, R.M. Zucker, J., Jr., Norwood, C.E. Grace, C.J. Gordon, and C. Lau. 2014. "Elevated Blood Pressure in Offspring of Rats Exposed to Diverse Chemicals During Pregnancy." *Toxicol. Sci.* 137(2): 436–446.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; one treatment level	

Reference: Sindermann, A.B., J.R. Porch, H.O. Krueger, and R.L. Van Hoven. 2002. *PFOS: An Acute Toxicity Study with the Earthworm in an Artificial Soil Substrate.* Project 454-111, Wildlife International Ltd., Easton, MD.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Van Gossum, H., B. Audenaert, and L. De Bruyn. 2010. "Perfluorooctane Sulfonic Acid Contamination Reduced Fitness in *Drosophila hydei* (Diptera: Drosophilidae)." *Ann. Entomol. Soc. Am.* 103(2): 247–251.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal only**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Xu, D., C. Li, Y. Wen, and W. Liu. 2013. "Antioxidant Defense System Responses and DNA Damage of Earthworms Exposed to Perfluorooctane". *Environ. Pollut.* 174: 121–127.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Yuan, Z., J. Zhang, L. Zhao, J. Li, and H. Liu. 2017. "Effects of Perfluorooctanoic Acid and Perfluorooctane Sulfonate on Acute Toxicity, Superoxide Dismutase, and Cellulase Activity in the Earthworm *Eisenia fetida*." *Environ. Sci. Pollut. Res. Int.* 24(22): 18188–18194.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only LC_{50} calculated	

Reference: Zareitalabad, P., J. Siemens, F. Wichern, W. Amelung, and R.G. Joergensen. 2013. "Dose-Dependent Reactions of *Aporrectodea caliginosa* to Perfluorooctanoic Acid and Perfluorooctanesulfonic." *Ecotoxicol. Environ. Saf.* 95: 39–43.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Zhao, H., C. Chen, X. Zhang, J. Chen, and X. Quan. 2011. "Phytotoxicity of PFOS and PFOA to *Brassica chinensis* in Different Chinese Soils." *Ecotoxicol. Environ. Saf.* 74(5): 1343–1347.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Zheng, X.Q., Y.J. Shi, Y.L. Lu, and X.B. Xu. 2016. "Growth Inhibition and DNA Damage in the Earthworm (*Eisenia fetida*) Exposed to Perfluorooctane Sulphonate and Perfluorooctanoic Acid." *Chem. Ecol.* 32(2): 103–116.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.6 EVALUATIONS OF PFOS STUDIES OF RODENTS

Reference: Abbott, B.D., C.J. Wolf, K.P. Das, et al. 2009. "Developmental toxicity of perfluorooctane sulfonate (PFOS) is not dependent on expression of peroxisome proliferator activated receptor-alpha (PPARα) in the mouse." ***Reprod. Toxicol.*** **27(3-4): 258–265.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<75%**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Butenhoff, J.L., S.C. Chang, G.W. Olsen, P.J. Thomford. 2012. "Chronic dietary toxicity and carcinogenicity study with potassium perfluorooctanesulfonate in Sprague Dawley rats." *Toxicology* 293: 1–15.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Case, M.T., R.G. York, M.S. Christian. 2001. "Rat and rabbit oral developmental toxicology studies with two perfluorinated compounds.: *Int. J. Toxicol.* 20(2): 101–109.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects are caused by a single chemical stressor (i.e., no mixture testing in laboratory studies.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Chen, T., L. Zhang, J.Q. Yue, et al. 2012. "Prenatal PFOS exposure induces oxidative stress and apoptosis in the lung of rat off-spring." ***Reprod. Toxicol.*** **33(4): 538–545.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Cui, L., Q.F. Zhou, C.Y. Liao, et al. 2009. "Studies on the toxicological effects of PFOA and PFOS on rats using histological observation and chemical analysis." ***Arch. Environ. Contam. Toxicol.*** **56(2): 338–349.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Era, S., K.H. Harada, M. Toyoshima, et al. 2009. "Cleft palate caused by perfluorooctane sulfonate is caused mainly by extrinsic factors." ***Toxicology*** **256(1-2): 42–47.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Fuentes, S., M.T. Colomina, P. Vicens, et al. 2007b. "Concurrent exposure to perfluoroactane sulfonate and restraint stress during pregnancy in mice: Effects on postnatal development and behavior of the offspring." ***Toxicol. Sci.*** **98: 589–598.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level	

Reference: Grasty, R.C., D.C. Wolf, B.E. Grey, et al. 2003. "Prenatal window of susceptibility to perfluorooctane sulfonate-induced neonatal mortality in the Sprague-Dawley rat (corrigendum in Birth Defects." *Res. B* 68(6): 465–471.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Lau, C., J.R. Thibodeaux, R.G. Hanson, et al. 2003. "Exposure to perfluorooctane sulfonate during pregnancy in rat and mouse. II: Postnatal evaluation." ***Toxicol. Sci.*** **74(2): 382–392.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Lee, C.K., S.G. Kang, J.T. Lee, et al. 2015. "Effects of perfluorooctane sulfuric acid on placental PRL-family hormone production and fetal growth retardation in mice." ***Mol. Cell. Endocrinol.*** **401: 165–172. 10.1016/j.mce.2014.10.026.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Lefebvre, D.E., I. Curran, C. Armstrong, et al. 2008. "Immunomodulatory effects of dietary potassium perfluorooctane sulfonate (PFOS) exposure in adult Sprague-Dawley rats." *J. Toxicol. Environ. Health A* 71(23): 1516–1525.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	
Human or primate subjects.	
In vitro studies, including cell cultures and excised tissues.	
Methods for measuring contaminants.	
Only modeling results reported.	
No viable plant or animal present or tested.	
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	
Data developed only from quantitative-structure activity relationships.	
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	
Assessment of toxicity in the field over a period of time.	
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	
The chemical form and concentration are reported.	
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	
The duration of the exposure is reported.	
Study used a control(s).	
At least three treatment levels are used (i.e., control plus two chemical exposures).	
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	
ACCEPT/REJECT: Have not obtained article but appears to be acceptable	

Reference: Luebker, D.J., M.T. Case, R.G. York, et al. 2005a. "Two-generation reproduction and cross-foster studies of perfluorooctanesulfonate (PFOS) in rats." ***Toxicology*** **215(1-2): 126–148.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Luebker, D.J., R.G. York, K.J. Hansen, et al. 2005b. "Neonatal mortality from in utero exposure to perfluorooctanesulfonate (PFOS) in Sprague-Dawley rats: Dose-response, and biochemical and pharmacokinetic parameters." ***Toxicology*** **215(1-2): 149–169.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Ngo, H.T., R.B. Hetland, A. Sabaredzovic, et al. 2014. "In utero exposure to perfluorooctanoate (PFOA) or perfluorooctane sulfonate (PFOS) did not increase body weight or intestinal tumorigenesis in multiple intestinal neoplasia (Min/+) mice." *Environ. Res.* 132: 251–263. 10.1016/j.envres.2014.03.033.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; no effect documented for PFOS	

Reference: Qazi, M.R., B.D. Nelson, J.W. Depierre, et al. 2010b. "28-Day dietary exposure of mice to a low total dose (7 mg/kg) of perfluorooctanesulfonate (PFOS) alters neither the cellular compositions of the thymus and spleen nor humoral immune responses: Does the route of administration play a pivotal role in PFOS-induced immunotoxicity?" *Toxicology* 267(1-3): 132–139.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level	

Reference: Rogers, J.M., R.G. Ellis-Hutchings, B.E. Grey, et al. 2014. "Elevated blood pressure in offspring of rats exposed to diverse chemicals during pregnancy." *Toxicol. Sci.* 137(2): 436–446.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; one treatment level	

Reference: Thibodeaux, J.R., R.G. Hanson, J.M. Rogers, et al. 2003. "Exposure to perfluorooctane sulfonate during pregnancy in rat and mouse. I: Maternal and prenatal evaluations." *Toxicol. Sci.* 74(2): 369–381.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Thomford, P.J. 2002. *104-Week dietary chronic toxicity and carcinogenicity study with perfluorooctane sulfonic acid potassium salt (PFOS; T-6295) in rats*. St. Paul, MN: 3M.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Vetvicka, V., J. Vetvickova. 2013. "Reversal of perfluorooctanesulfonate-induced immunotoxicity by a glucan-resverarol-vitamin C combination." ***Oriental Pharmacy and Experimental Medicine*** **13(1): 77–84.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; only one treatment level	

Reference: Wan, H.T., Y.G. Zhao, M.H. Wong, et al. 2011. "Testicular signaling is the potential target of perfluorooctanesulfonate-mediated subfertility in male mice." ***Biol. Reprod.*** **84(5): 1016–1023.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Xing, J., G. Wang, J. Zhao, et al. 2016. "Toxicity assessment of perfluorooctane sulfonate using acute and subchronic male C57BL/6J mouse models." ***Environ. Pollut.*** **210: 388–396.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.7 EVALUATIONS OF STUDIES OF AQUATIC SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFBA

Reference: Barmentlo, S.H., J.M. Stel, M. Van Doorn, C. Eschauzier, P. De Voogt, and M.H.S. Kraak. 2015. "Acute and Chronic Toxicity of Short Chained Perfluoroalkyl Substances to *Daphnia magna*." *Environ. Pollut.*198: 47–53.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Boudreau, T.M. 2002. *Toxicity of Perfluorinated Organic Acids to Selected Freshwater Organisms Under Laboratory and Field Conditions*. M.S. Thesis, University of Guelph, Ontario, Canada.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ding, G., M. Wouterse, R. Baerselman, and W.J.G.M. Peijnenburg. 2012b. "Toxicity of Polyfluorinated and Perfluorinated Compounds to Lettuce (*Lactuca sativa*) and Green Algae (*Pseudokirchneriella subcapitata*)." *Arch. Environ. Contam. Toxicol*. 62(1): 49–55.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal only**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Ding, G.H., T. Fromel, E.J. Van den Brandhof, R. Baerselman, and W.J.G.M. Peijnenburg. 2012a. "Acute Toxicity of Poly- and Perfluorinated Compounds to Two Cladocerans, *Daphnia magna* and *Chydorus sphaericus*." *Environ. Toxicol. Chem*. 31(3): 605–610.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Godfrey, A., A. Abdel-Moneim, and M.S. Sepulveda. 2017. "Acute mixture toxicity of halogenated chemicals and their next generation counterparts on zebrafish embryos." *Chemosphere* 181: 710–712.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Godfrey, A., B. Hooser, A. Abdelmoneim, K.A. Horzmann, J.L. Freemanc, and M.S. Sepulveda. 2017. "Thyroid Disrupting Effects of Halogenated and Next Generation Chemicals on the Swim Bladder Development of Zebrafish." ***Aquat. Toxicol.*** **193: 228–235.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one exposure level used	

Reference: Hagenaars, A., L. Vergauwen, W. De Coen, and D. Knapen. 2011. "Structure-Activity Relationship Assessment of Four Perfluorinated Chemicals Using a Prolonged Zebrafish Early Life Stage Test." *Chemosphere* 82: 764–772.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ulhaq, M., G. Carlsson, S. Orn, and L. Norrgren. 2013. "Comparison of Developmental Toxicity of Seven Perfluoroalkyl Acids to Zebrafish Embryos." *Environ. Toxicol. Pharmacol.* 36: 423–426.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Wang, Y., J. Niu, L. Zhang, and J. Shi. 2014. "Toxicity Assessment of Perfluorinated Carboxylic Acids (PFCAs) Towards the Rotifer *Brachionus calyciflorus*." *Sci. Total Environ*. 491/492: 266–270.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.8 EVALUATIONS OF PFBA STUDIES OF RODENTS

Reference: Das, P., B.E. Grey, R.D. Zehr, C.R. Wood, J.L. Butenhoff, S.-C. Chang, D.J. Ehresman, Y.-M. Tan, and C. Lau. 2008. "Effects of Perfluorobutyrate Exposure during Pregnancy in the Mouse." *Toxicological Sciences* 105(1): 173–181.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.9 EVALUATIONS OF STUDIES OF AQUATIC SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFDA

Reference: Boudreau, T.M. 2002. *Toxicity of Perfluorinated Organic Acids to Selected Freshwater Organisms Under Laboratory and Field Conditions*. M.S. Thesis, University of Guelph, Ontario, Canada.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ding, G., M. Wouterse, R. Baerselman, and W.J.G.M. Peijnenburg. 2012. "Toxicity of Polyfluorinated and Perfluorinated Compounds to Lettuce (*Lactuca sativa*) and Green Algae (*Pseudokirchneriella subcapitata*)." *Arch. Environ. Contam. Toxicol*. 62(1): 49–55.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal only**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Ding, G.H., T. Fromel, E.J. Van den Brandhof, R. Baerselman, and W.J.G.M. Peijnenburg. 2012a. "Acute Toxicity of Poly- and Perfluorinated Compounds to Two Cladocerans, *Daphnia magna* and *Chydorus sphaericus*." *Environ. Toxicol. Chem*. 31(3): 605–610.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hoke, R.A., L.D. Bouchelle, B.D. Ferrell, R.C. Buck. 2012. "Comparative acute freshwater hazard assessment and preliminary PNEC development for eight fluorinated acids." *Chemosphere* 87: 725–733.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ishibashi, H., R. Yamauchi, M. Matsuoka, J.-W. Kim, M. Hirano, A. Yamaguchi, N. Tominaga, K. Arizono. 2008. "Fluorotelomer alcohols induce hepatic vitellogenin through activation of the estrogen receptor in male medaka (*Oryzias latipes*)." *Chemosphere* 71: 1853–1859.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect on ecologically relevant endpoint found	

Reference: Jeon, J., K. Kannan, H.K. Lim, H.B. Moon, J.S. Ra, and S.D. Kim. 2010. "Bioaccumulation of Perfluorochemicals in Pacific Oyster Under Different Salinity Gradients." *Environ. Sci. Technol.* 44(7): 2695–2701.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**Y**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects reported for growth, mortality or reproduction	

Reference: Jo, A., K. Ji, and K. Choi. 2014. Endocrine Disruption Effects of Long-Term Exposure to Perfluorodecanoic Acid (PFDA) and Perfluorotridecanoic Acid (PFTrDA) in Zebrafish (*Danio rerio*) and Related Mechanisms." *Chemosphere* 108: 360–366.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**Y**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, C., V.W.C. Chang, and K.Y.H. Gin. 2014. "Oxidative Toxicity of Perfluorinated Chemicals in Green Mussel and Bioaccumulation Factor Dependent Quantitative Structure-Activity Relationship." *Environ. Toxicol. Chem*. 33(10): 2323–2332.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**Y**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects reported for growth, mortality or reproduction	

Reference: Matsubara, E., K. Harada, K. Inoue, and A. Koizumi. 2006. "Effects of Perfluorinated Amphiphiles on Backward Swimming in *Paramecium caudatum*." *Biochem. Biophys. Res. Commun*. 339(2): 554–561.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**Y**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; studies cells and no effects on growth, mortality, or reproduction were reported	

Reference: Mitchell, R.J. 2009. *Effects of FTCAs on the embryological and larval development of Xenopus laevis: Determining mechanisms of action. Chapter 4 in Toxicity of Fluorotelomer Acids to Freshwater organisms and a preliminary evaluation of Mechanism of Action*. Thesis submitted to the University of Guelph.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**Y**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only one treatment level used	

Reference: Ulhaq, M., G. Carlsson, S. Orn, and L. Norrgren. 2013. "Comparison of Developmental Toxicity of Seven Perfluoroalkyl Acids to Zebrafish Embryos." *Environ. Toxicol. Pharmacol.* 36: 423–426.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhai, Y., X. Xia, X. Zhao, H. Dong, B. Zhu, N. Xia, and J. Dong. 2016. "Role of Ingestion Route in the Perfluoroalkyl Substance Bioaccumulation by *Chironomus plumosus* Larvae in Sediments Amended with Carbonaceous Materials." *J. Hazard. Mater*. 302: 404–414.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject because no effect on mortality reported and only 1 treatment level used	

F.10 EVALUATIONS OF PFDA STUDIES OF RODENTS

Reference: Harris, M.W., L.S. Birnbaum. 1989. "Developmental toxicity of perfluorodecanoic acid in C57BL/6N mice." ***Fundam. Appl. Toxicol.*** **12: 442–448.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal only**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Harris, M.W., L.C. Uraih, L.S. Birnbaum. 1989. "Acute toxicity of perfluorodecanoic acid in C57BL/6 mice differs from 2,3,7,8-tetrachlorodibenzo-p-dioxin." *Fundam. Appl. Toxicol.* 13: 723–726.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Kawabata, K., H. Matsuzaki, S. Nukui, et al. 2017. "Perfluorododecanoic acid induces cognitive deficit in adult rats." *Toxicol. Sci.* 157(2): 421–428.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; one treatment level	

Reference: Kawashima, Y., H. Kobayashi, H. Miura, et al. 1995. "Characterization of hepatic responses of rat to administration of perfluorooctanoic and perfluorodecanoic acids at low levels." *Toxicology* 99(3): 169–178.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; no effect reported	

F.11 EVALUATIONS OF STUDIES OF AQUATIC SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFHXA

Reference: Annunziato, K.M., C.E. Jantzen, M.C. Gronske, K.R. Cooper. 2019. "Subtle morphometric, behavioral and gene expression effects in larval zebrafish exposed to PFHxA, PFHxS and 6:2 FTOH." *Aquatic Toxicology* 208: 126–137.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Barmentlo, S., J.M. Stel, M. van Doorn, C. Eschauzier, P. de Voogt, M. H.S. Kraak. 2015. "Acute and chronic toxicity of short chained perfluoroalkyl substances to *Daphnia magna*." *Aquat. Environmental Pollution* 198: 47–53.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Latala, A., M. Nedzi, and P. Stepnowski. 2008. "Acute Toxicity Assessment of Perfluorinated Carboxylic Acids Towards the Baltic Microalgae." ***Environ. Toxicol. Pharmacol.*** **28(2): 167–171.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, W., S. Chen, X. Quan, and Y.H. Jin. 2008. "Toxic Effect of Serial Perfluorosulfonic and Perfluorocarboxylic Acids on the Membrane System of a Freshwater Alga Measured by Flow Cytometry." *Environ. Toxicol. Chem*. 27(7): 1597–1604.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject due to no effect on a relevant endpoint	

Reference: Wang, Y., J. Niu, L. Zhang, and J. Shi. 2014. "Toxicity Assessment of Perfluorinated Carboxylic Acids (PFCAs) Towards the Rotifer *Brachionus calyciflorus*." *Sci. Total Environ*. 491/492: 266–270.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Not reported**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.12 EVALUATION OF PFHXA STUDIES OF RODENTS

Reference: Iwai, H., A.M. Hoberman. 2014. "Oral (gavage) combined developmental and perinatal/postnatal reproduction toxicity study of ammonium salt of perfluorinated hexanoic acid in mice." ***Int. J. Toxicol.*** **33(3): 219–237.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Klaunig, J.E., M. Shinohara, H. Iwai, et al. 2015. "Evaluation of the chronic toxicity and carcinogenicity of perfluorohexanoic acid (PFHxA) in Sprague-Dawley rats." ***Toxicol. Pathol.*** **43(2): 209–220.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**N**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; high control mortality	

F.13 EVALUATIONS OF STUDIES OF AQUATIC SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFNA

Reference: Boudreau, T.M. 2002. *Toxicity of Perfluorinated Organic Acids to Selected Freshwater Organisms Under Laboratory and Field Conditions*. M.S. Thesis, University of Guelph, Ontario, Canada.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ding, G., M. Wouterse, R. Baerselman, and W.J.G.M. Peijnenburg. 2012. "Toxicity of Polyfluorinated and Perfluorinated Compounds to Lettuce (*Lactuca sativa*) and Green Algae (*Pseudokirchneriella subcapitata*)." *Arch. Environ. Contam. Toxicol*. 62(1): 49–55.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal only**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Ding, G.H., T. Fromel, E.J. Van den Brandhof, R. Baerselman, and W.J.G.M. Peijnenburg. 2012a. "Acute Toxicity of Poly- and Perfluorinated Compounds to Two Cladocerans, *Daphnia magna* and *Chydorus sphaericus*." *Environ. Toxicol. Chem*. 31(3): 605–610.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hoke, R.A., L.D. Bouchelle, B.D. Ferrell, R.C. Buck. 2012. "Comparative acute freshwater hazard assessment and preliminary PNEC development for eight fluorinated acids." *Chemosphere* 87: 725–733.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ishibashi, H., R. Yamauchi, M. Matsuoka, J.-W. Kim, M. Hirano, A. Yamaguchi, N. Tominaga, K. Arizono. 2008. "Fluorotelomer alcohols induce hepatic vitellogenin through activation of the estrogen receptor in male medaka (*Oryzias latipes*)." *Chemosphere* 71:1853–1859.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect on ecologically relevant endpoint found	

Reference: Jantzen, C.E., K.A. Annunziato, S.M. Bugel, and K.R. Cooper. 2016a. "PFOS, PFNA, and PFOA Sub-Lethal Exposure to Embryonic Zebrafish have Different Toxicity Profiles in Terms of Morphometrics, Behavior and Gene Expression." *Aquat. Toxicol.* 175: 160–170.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20% for all tx**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Jantzen, C.E., K.A. Annunziato, S.M. Bugel, and K.R. Cooper. 2016b. "Behavioral, morphometric, and gene expression effects in adult zebrafish (*Danio rerio*) embryonically exposed to PFOA, PFOS, and PFNA." *Aquat. Toxicol.* 180: 123–130.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**<20% for all tx**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; only 1 treatment level	

Reference: Latala, A., M. Nedzi, and P. Stepnowski. 2008. "Acute Toxicity Assessment of Perfluorinated Carboxylic Acids Towards the Baltic Microalgae." ***Environ. Toxicol. Pharmacol.*** **28(2): 167–171.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, C., V.W.C. Chang, and K.Y.H. Gin. 2014. "Oxidative Toxicity of Perfluorinated Chemicals in Green Mussel and Bioaccumulation Factor Dependent Quantitative Structure-Activity Relationship." *Environ. Toxicol. Chem*. 33(10): 2323–2332.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**Y**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effects reported for growth, mortality or reproduction	

Reference: Lu, G., J. Liu, L. Sun, and L. Yuan. 2015. "Toxicity of Perfluorononanoic Acid and Perfluorooctane Sulfonate to *Daphnia magna*." *Water Sci. Eng*. 8(1): 40–48.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, H., N. Sheng, W. Zhang, J. Dai1. 2015. "Toxic effects of perfluorononanoic acid on the development of Zebrafish (*Danio rerio*) embryos." *Journal of Environmental Sciences* 32: 26–34.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Matsubara, E., K. Harada, K. Inoue, and A. Koizumi. 2006. "Effects of Perfluorinated Amphiphiles on Backward Swimming in *Paramecium caudatum*." *Biochem. Biophys. Res. Commun*. 339(2): 554–561.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; studies cells; no effects on growth, mortality, or reproduction were reported	

Reference: Menger, F., J. Pohl, L. Ahrens, G. Carlsson, S. Orn. 2020. "Behavioural effects and bioconcentration of per- and polyfluoroalkyl substances (PFASs) in zebrafish (*Danio rerio*) embryos." *Chemosphere* 245: 125573.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Ulhaq, M., G. Carlsson, S. Orn, and L. Norrgren. 2013. "Comparison of Developmental Toxicity of Seven Perfluoroalkyl Acids to Zebrafish Embryos." *Environ. Toxicol. Pharmacol.* 36: 423–426.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not Described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhai, Y., X. Xia, X. Zhao, H. Dong, B. Zhu, N. Xia, and J. Dong. 2016. "Role of Ingestion Route in the Perfluoroalkyl Substance Bioaccumulation by *Chironomus plumosus* Larvae in Sediments Amended with Carbonaceous Materials." *J. Hazard. Mater*. 302: 404–414.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect on mortality reported and only 1 treatment level used	

Reference: Zhang, W., Y. Zhang, H. Zhang, J. Wang, R. Cui, and J. Dai. 2012. "Sex Differences in Transcriptional Expression of FABPs in Zebrafish Liver After Chronic Perfluorononanoic Acid Exposure." *Environ. Sci. Technol.* 46(9): 5175–5182.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zhang, W., N. Sheng, M. Wang, H. Zhang, and J. Dai. 2016. "Zebrafish reproductive toxicity induced by chronic perfluorononanoate exposure." ***Aquatic Toxicology*** **175: 269–276.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Zheng, X.M., H.L. Liu, W. Shi, S. Wei, J.P. Giesy, and H.X. Yu. 2012. "Effects of Perfluorinated Compounds on Development of Zebrafish Embryos." *Environ. Sci. Pollut. Res.* 19(7): 2498–2505.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.14 EVALUATIONS OF STUDIES OF TERRESTRIAL SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFNA

Reference: DuPont Co. 1985. "Repeated Dose Oral Toxicity Study Mice/Crl:CD®-1 (ICR)BR." Unpublished Data, Haskell Laboratory Report No. 401-85. From Summaries of Studies Conducted at DuPont Haskell Laboratory with Ammonium Perfluorooctanoate and Perfluorononanoate, (with Cover Letter Dated 052500). EPA/OTS Doc #FYI-OTS-0600-1378.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson. 2018. "Perfluoroalkylsulfonic and Carboxylic Acids in Earthworms (*Eisenia fetida*): Accumulation and Effects Results from Spiked Soils at PFAS Concentrations Bracketing Environmental Relevance." *Chemosphere* 199: 168–173.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.15 EVALUATION OF PFNA STUDIES OF RODENTS

Reference: Das, K.P., B.E. Grey, M.B. Rosen, et al. 2015. "Developmental toxicity of perfluorononanoic acid in mice." ***Reprod. Toxicol.*** **51: 133–144.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Rogers, J.M., R.G. Ellis-Hutchings, B.E. Grey, R.M. Zucker, J., Jr., Norwood, C.E. Grace, C.J. Gordon, and C. Lau. 2014. "Elevated Blood Pressure in Offspring of Rats Exposed to Diverse Chemicals During Pregnancy." *Toxicol. Sci.* 137(2): 436–446.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**N**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Reject; one treatment level	

Reference: Wolf, C.J., R.D. Zehr, J.E. Schmid, et al. 2010. "Developmental effects of perfluorononanoic Acid in the mouse are dependent on peroxisome proliferator-activated receptor-alpha." ***PPAR Res*** **2010: 282896.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.16 EVALUATIONS OF STUDIES OF AQUATIC SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFBS

Reference: Hagenaars, A., L. Vergauwen, W. De Coen, and D. Knapen. 2011. "Structure-Activity Relationship Assessment of Four Perfluorinated Chemicals Using a Prolonged Zebrafish Early Life Stage Test." *Chemosphere* 82: 764–772.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Liu, W., S. Chen, X. Quan, and Y.H. Jin. 2008. "Toxic Effect of Serial Perfluorosulfonic and Perfluorocarboxylic Acids on the Membrane System of a Freshwater Alga Measured by Flow Cytometry." *Environ. Toxicol. Chem*. 27(7): 1597–1604.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Lou, Q.Q., Y.F. Zhang, Z. Zhou, Y.L. Shi, Y.N. Ge, D.K. Ren, H.M. Xu, Y.X. Zhao, W.J. Wei, and Z.F. Qin. 2013. "Effects of Perfluorooctanesulfonate and Perfluorobutanesulfonate on the Growth and Sexual Development of *Xenopus laevis*." *Ecotoxicology* 22(7): 1133–1144.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; no effect on growth mortality or reproduction	

Reference: Matsubara, E., K. Harada, K. Inoue, and A. Koizumi. 2006. "Effects of Perfluorinated Amphiphiles on Backward Swimming in *Paramecium caudatum*. *Biochem. Biophys. Res. Commun*. 339(2): 554–561.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; studies cells; no effects on growth, mortality, or reproduction were reported	

Reference: Rosal, R., I. Rodea-Palomares, K. Boltes, F. Fernandez-Pinas, F. Leganes, and A. Petre. 2010. "Ecotoxicological Assessment of Surfactants in the Aquatic Environment: Combined Toxicity of Docusate Sodium with Chlorinated Pollutants." *Chemosphere* 81(2): 288–293.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Stefani, F., M. Rusconi, S. Valsecchi, and L. Marziali. 2014. "Evolutionary Ecotoxicology of Perfluoralkyl Substances (PFASs) Inferred from Multigenerational Exposure: A Case Study with *Chironomus riparius* (Diptera, Chironomidae)." *Aquat. Toxicol.* 156: 41–51.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**N**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Reject; 1 treatment level	

Reference: Ulhaq, M., G. Carlsson, S. Orn, and L. Norrgren. 2013. "Comparison of Developmental Toxicity of Seven Perfluoroalkyl Acids to Zebrafish Embryos." *Environ. Toxicol. Pharmacol.* 36: 423–426.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not reported**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.17 EVALUATIONS OF STUDIES OF TERRESTRIAL SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFBS

Reference: Leider, P.H., R.G. York, D.C. Hakes, S.-C. Chang, and J.L. Butenhoff. 2009a. "A two-generation oral gavage reproduction study with potassium perfluorobutanesulfonate (K+PFBS) in Sprague Dawley rats." *Toxicology* 259: 33–45.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Lieder, P.H., S-C. Chang, R.G. York, J.L. Butenhoff. 2009b. "Toxicological evaluation of potassium perfluorobutanesulfonate in a 90-day oral gavage study with Sprague–Dawley rats." *Toxicology* 259: 45–52.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson. 2018. "Perfluoroalkylsulfonic and Carboxylic Acids in Earthworms (*Eisenia fetida*): Accumulation and Effects Results from Spiked Soils at PFAS Concentrations Bracketing Environmental Relevance." *Chemosphere* 199: 168–173.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Newsted, J.L., S.A. Beach, S.P. Gallagher, and J.P. Giesy. 2008. "Acute and Chronic Effects of Perfluorobutane Sulfonate (PFBS) on the Mallard and Northern Bobwhite Quail." ***Arch. Environ. Contam. Toxicol.*** **54(3): 535–545.**	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**Y**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

F.18 EVALUATIONS OF STUDIES OF AQUATIC SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFHXS

Reference: Annunziato, K.M., C.E. Jantzen, M.C. Gronske, K.R. Cooper. 2019. "Subtle morphometric, behavioral and gene expression effects in larval zebrafish exposed to PFHxA, PFHxS and 6:2 FTOH." *Aquatic Toxicology* 208: 126–137.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Nominal**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Hoover, G.M., M.F. Chislock, B.J. Tornabene, S.C. Guffey, Y.J. Choi, C. De Perre, J.T. Hoverman, L.S. Lee, and M.S. Sepu. 2017. "Uptake and Depuration of Four Per/Polyfluoroalkyl Substances (PFASs) in Northern Leopard Frog *Rana pipiens* Tadpoles." *Environ. Sci. Technol. Lett.* 4(10): 399–403.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Not described**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

Reference: Menger, F., J. Pohl, L. Ahrens, G. Carlsson, S. Orn. 2020. "Behavioural effects and bioconcentration of per- and polyfluoroalkyl substances (PFASs) in zebrafish (*Danio rerio*) embryos." *Chemosphere* 245: 125573.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**NA**
ACCEPT/REJECT: Accept	

F.19 EVALUATIONS OF STUDIES OF TERRESTRIAL SPECIES FOR USE IN IDENTIFYING ECOLOGICAL SCREENING VALUES FOR PFHXS

Reference: Butenhoff, J.L., S-C Chang, D.J. Ehresman, R.G. York. 2009. "Evaluation of potential reproductive and developmental toxicity of potassium perfluorohexanesulfonate in Sprague Dawley rats." *Reproductive Toxicology* 27: 331–341.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**Y**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Chang S., J.L. Butenhoff, G.A. Parker, P.S. Coder, J.D. Zitzow, R.M. Krisko, J.A. Bjork, K.B. Wallace, J.G. Seed. 2018. "Reproductive and developmental toxicity of potassium perfluorohexanesulfonate in CD-1 mice." *Reproductive Toxicology* 78:150–168.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	

Reference: Karnjanapiboonwong, A., S.K. Deb, S. Subbiah, D. Wang, and T.A. Anderson. 2018. "Perfluoroalkylsulfonic and Carboxylic Acids in Earthworms (*Eisenia fetida*): Accumulation and Effects Results from Spiked Soils at PFAS Concentrations Bracketing Environmental Relevance." *Chemosphere* 199: 168–173.	
STUDY EXCLUSION CRITERIA	
Fate and transport of substance in the environment (only).	**N**
Human or primate subjects.	**N**
In vitro studies, including cell cultures and excised tissues.	**N**
Methods for measuring contaminants.	**N**
Only modeling results reported.	**N**
No viable plant or animal present or tested.	**N**
No effect was reported for a biological test species.	**N**
Study is not the primary source or author states information is published in another source.	**N**
Data developed only from quantitative-structure activity relationships.	**N**
Data reported are not primary data.	**N**
Adverse effects were not caused by a single chemical stressor.	**N**
Assessment of toxicity in the field over a period of time.	**N**
STUDY ACCEPTANCE CRITERIA	
Either the test species' scientific name, common name, variety, or strain is reported.	**Y**
The chemical form and concentration are reported.	**Y**
Nominal or measured dose or concentration is reported, or able to be calculated from information given.	**Y**
The duration of the exposure is reported.	**Y**
Study used a control(s).	**Y**
At least three treatment levels are used (i.e., control plus two chemical exposures).	**Y**
Control mortality (or other endpoint under investigation) is acceptable based on the species and endpoint under consideration.	**Y**
A calculated endpoint is reported (e.g., LC_{50}, LOEL, NOAEL)	**Y**
Study effects are ecologically relevant endpoints related to growth, mortality, and reproduction.	**N**
Administered doses are provided or can be calculated from the information provided in the study (wildlife only)	**Y**
ACCEPT/REJECT: Accept	