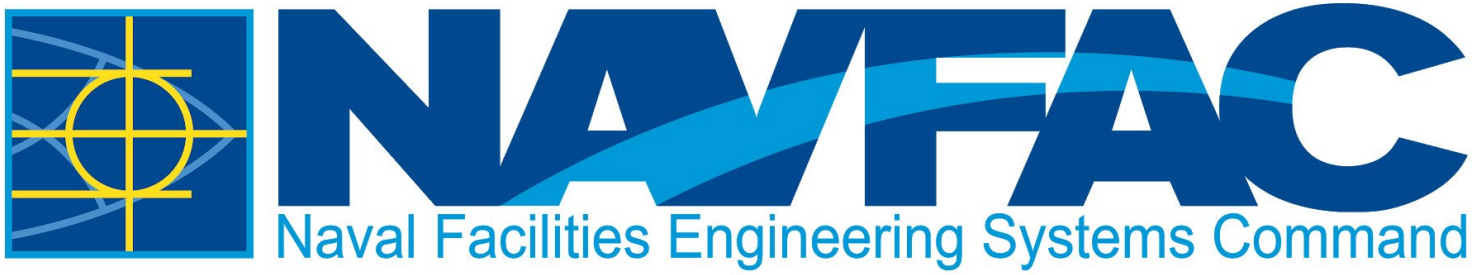

Risk Assessment Basics for Ecological Concerns with Emphasis on PFAS

Jason Speicher, NAVFAC Atlantic

FRTR Fall 2024 General Meeting

October 29, 2024

Prepared for FRTR October 2024 Meeting

General Disclaimer

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Speaker Introduction

Jason Speicher, MBA

Physical Scientist
NAVFAC Atlantic

- ERA SME for NAVFAC Atlantic
- Provide SME support to both active (ERN) and closed (BRAC) Navy facilities
- Provide policy and guidance support to Navy management
- Member of the SERDP/Environmental Security Technology Certification Program's Technical Advisory Committee for research associated with PFAS and contaminated sediments
- Member of Navy's Emerging Chemicals Workgroup
- Former steering committee member for the USEPA Ecological Soil Screening Level (Eco-SSL) effort
- Currently working with various Navy and DoD researchers on efforts to fill knowledge gaps for toxicity and bioaccumulation associated with PFAS

BRAC: Base Realignment and Closure
DoD: Department of Defense
ERA: ecological risk assessment
ERN: Environmental Restoration

MBA: Master of Business Administration
NAVFAC: Naval Facilities Engineering Systems Command
PFAS: per- and polyfluoroalkyl substances

SERDP: Strategic Environmental Research and Development Program
USEPA: United States Environmental Protection Agency

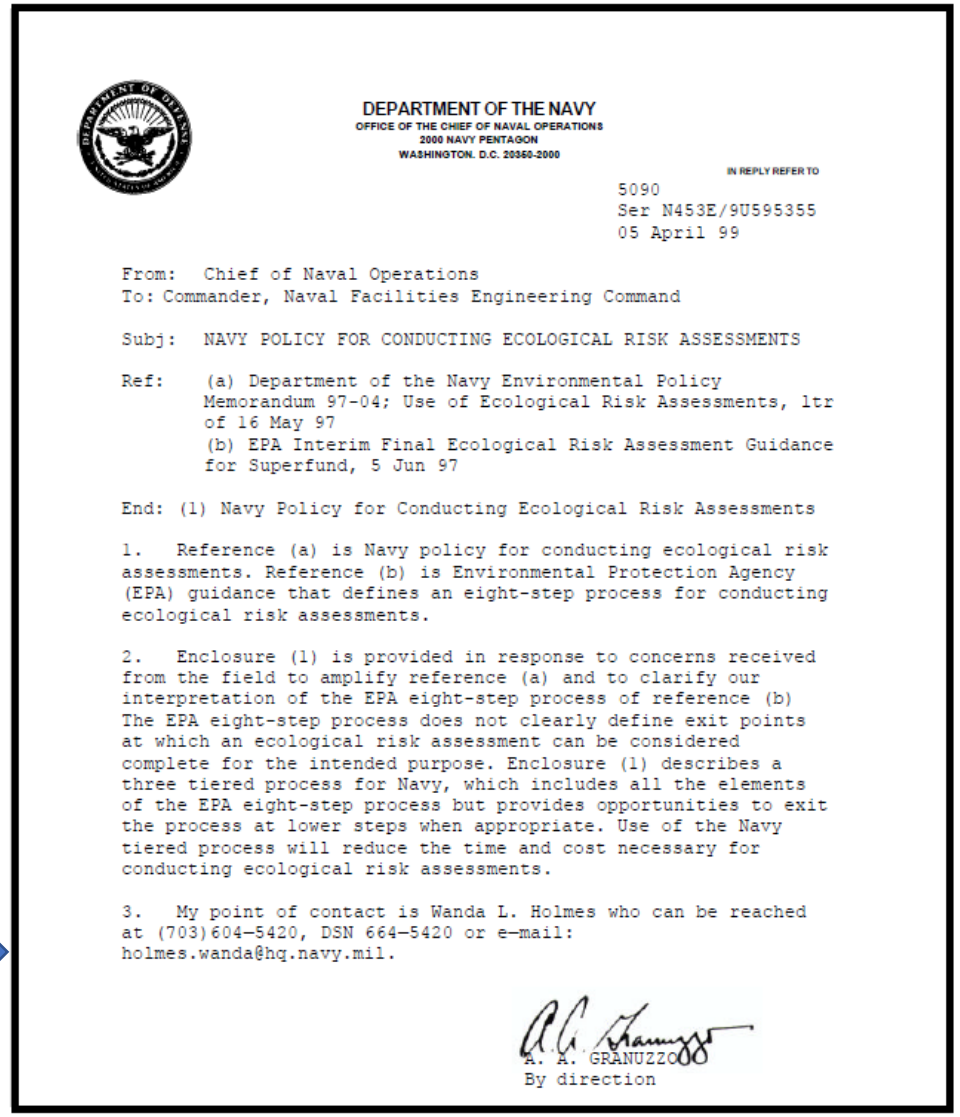
Presentation Overview

- ERA 101 – The Refresher – Not PFAS Specific
- ERA for PFAS: Pondering the Questions??????
- Summary/Closing Thoughts

Navy Guidance for Ecological Risk Assessments (ERAs)

- DoD DERP and Navy NERP Guidance provide basis for completing risk assessments under the CERCLA and RCRA processes
- Existing DoD and Navy policy and standard practice/guidance mirrors USEPA ERA Guidance (1997)
  - Navy ERA Policy (1999) provides tiered process
- NAVFAC (2022) guidance should be followed for ERAs at CERCLA and RCRA sites

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act
DERP: Defense Environmental Restoration Program
RCRA: Resource Conservation and Recovery Act



DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

IN REPLY REFER TO
5090
Ser N453E/9U595355
05 April 99

From: Chief of Naval Operations
To: Commander, Naval Facilities Engineering Command

Subj: NAVY POLICY FOR CONDUCTING ECOLOGICAL RISK ASSESSMENTS

Ref: (a) Department of the Navy Environmental Policy Memorandum 97-04; Use of Ecological Risk Assessments, ltr of 16 May 97
(b) EPA Interim Final Ecological Risk Assessment Guidance for Superfund, 5 Jun 97

End: (1) Navy Policy for Conducting Ecological Risk Assessments

1. Reference (a) is Navy policy for conducting ecological risk assessments. Reference (b) is Environmental Protection Agency (EPA) guidance that defines an eight-step process for conducting ecological risk assessments.

2. Enclosure (1) is provided in response to concerns received from the field to amplify reference (a) and to clarify our interpretation of the EPA eight-step process of reference (b) The EPA eight-step process does not clearly define exit points at which an ecological risk assessment can be considered complete for the intended purpose. Enclosure (1) describes a three tiered process for Navy, which includes all the elements of the EPA eight-step process but provides opportunities to exit the process at lower steps when appropriate. Use of the Navy tiered process will reduce the time and cost necessary for conducting ecological risk assessments.

3. My point of contact is Wanda L. Holmes who can be reached at (703)604-5420, DSN 664-5420 or e-mail: holmes.wanda@hq.navy.mil.

A. A. GRANUZZO
By direction

What is ERA?

> "…a process that evaluates the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more stressors"
>
> -USEPA (1997)

- ERAs are often part of a larger process that seeks to answer the following questions
  - Are chemicals at a particular site causing adverse effects to ecological resources?
  - Should action be taken to address effects?
  - What should be done (where, how, when)?
    - "To dig, or not to dig, that is the question"

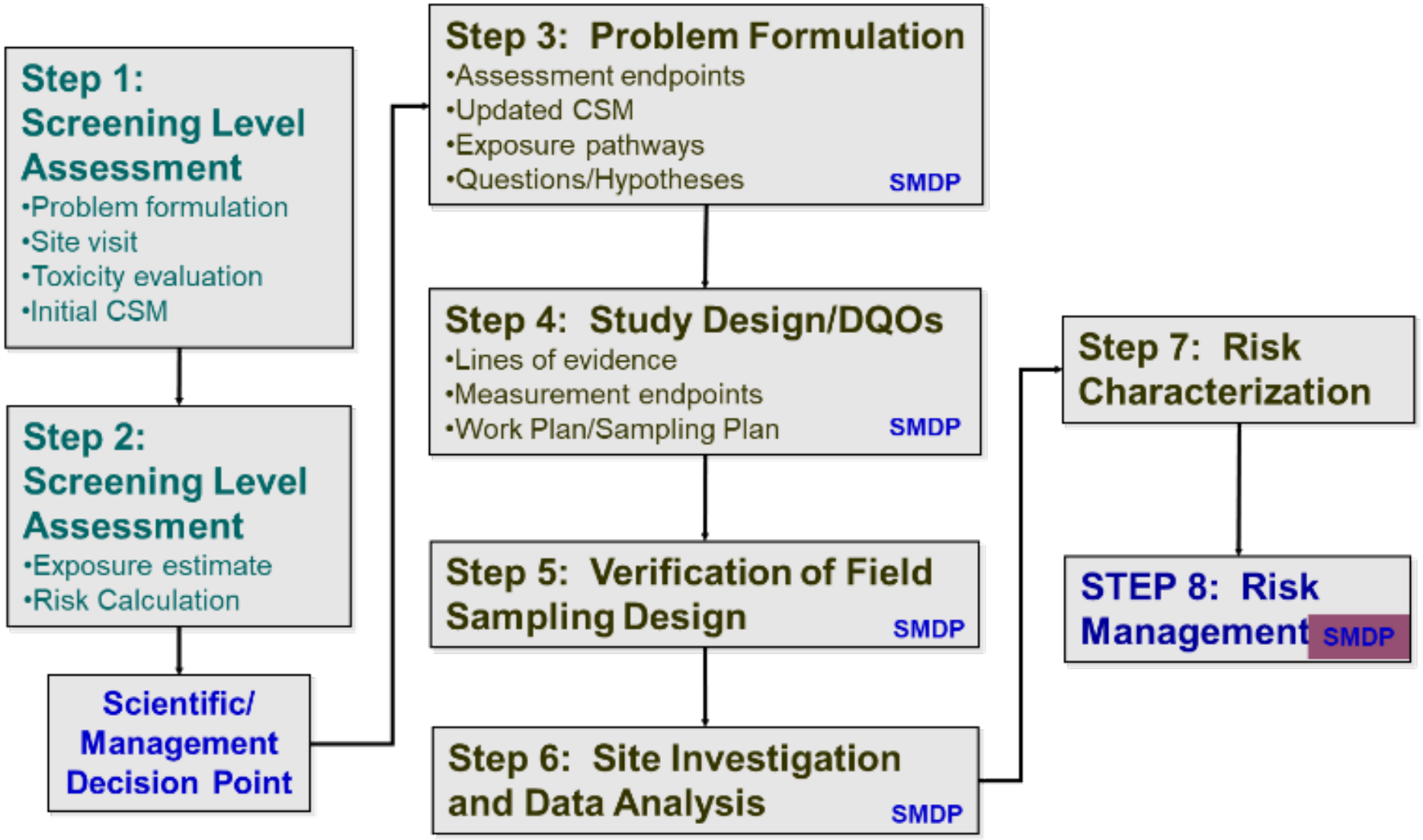
(Pixabay n.d.)

Guiding Principles of ERA

- "The dose makes the poison"
  - Paracelsus, 1500s
- "First, do no harm"
  - Auguste François Chomel, early 1800s (not Hippocrates)
- "A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise"
  - Aldo Leopold, *A Sand County Almanac*, 1947
- "Don't do anything stupid"
  - Glenn Suter (USEPA), *Ecological Risk Assessment for Contaminated Sites*, 2000

ERA Overview: CERCLA

1997 USEPA Superfund Guidance for ERA (aka ERAGs)



CSM: conceptual site model
ERAG: Ecological Risk Assessment Guidance
SMDP: Scientific Management Decision Point

ERA Overview: NAVFAC

RPM Input and Risk Management Consideration
Step 8: Risk Management

Tier 1. Screening Ecological Risk Assessment (SERA): Identify pathways and compare exposure point concentrations to benchmarks

Step 1: Site Visit; Pathway Identification/Problem Formulation; Toxicity Evaluation
Step 2: Exposure Estimate; Risk Calculation (SMDP)
Proceed to Exit Criteria for SERA

SMDP: Exit Criteria for the SERA
1) Site passes SERA: A determination is made that the site poses acceptable risk and shall be closed out for ecological concerns.
2) Site fails SERA: Pathways complete and potential unacceptable risk.

Proceed to Tier 2 or Interim Cleanup

Tier 2. Baseline Ecological Risk Assessment (BERA)

Step 3a: Refinement of Conservative SERA Exposure Assumptions
Proceed to Exit Criteria for Step 3a

SMDP: Exit Criteria Step 3a
1) If re-evaluation of the conservative exposure assumptions (SERA) support an acceptable risk determination, then exit the ecological risk assessment process.
2) If re-evaluation of the conservative exposure assumptions (SERA) do not support an acceptable
continue the BERA process.

Proceed to Step 3b

Step 3b: Problem Formulation—Toxicity Evaluation; Assessment Endpoints; Conceptual Model; Risk Hypothesis (SMDP)
Step 4: Study Design/DQO—Lines of Evidence; Measurement Endpoints; UFP-SAP (SMDP)
Step 5: Verification of Field Sampling Design (SMDP)
Step 6: Site Investigation and Data Analysis (SMDP)
Step 7: Risk Characterization
Proceed to Exit Criteria for BERA

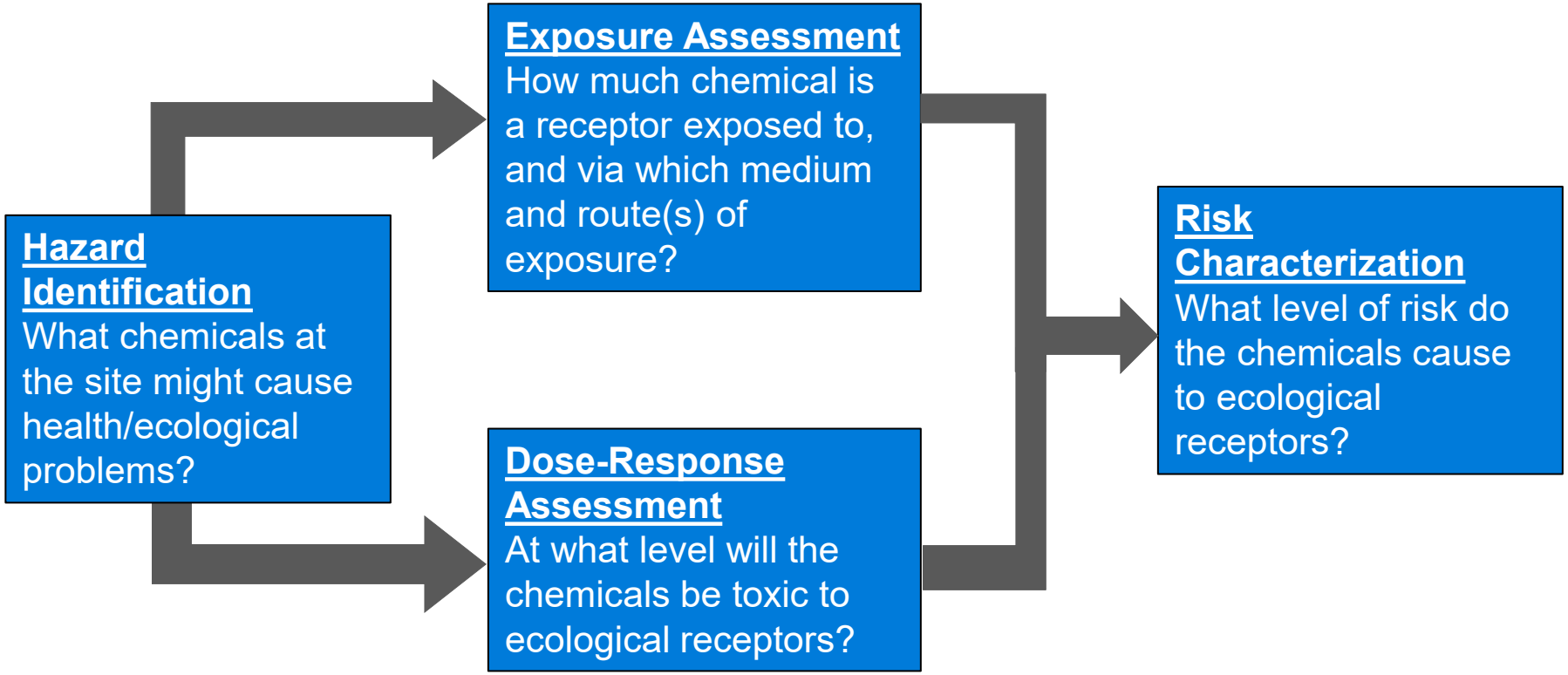
SMDP: Exit Criteria for the BERA
1) If the site poses acceptable risk, then no further evaluation and no remediation from an ecological perspective is warranted.
2) If the site poses unacceptable ecological risk and additional evaluation in the form of remedy development and evaluation is appropriate, proceed to third tier.

Tier 3. Evaluation of Remedial Alternatives (RAGS C)

a. Develop site-specific risk based cleanup values
b. Qualitatively evaluate risk posed to the environment by implementation of each alternative (short-term) impacts and estimate risk reduction provided by each (long-term) impacts; provide quantitative evaluation where appropriate. Weigh
aining CERCLA Nine Evaluation
ring and site closeout.

Just a different framing of the same key technical steps!

Four Basic Scientific Parts to Any Risk Assessment



Tier 1 Screening Ecological Risk Assessment (SERA)

- SERA
  - Do we need an ERA?
  - What receptors are exposed (and how)?
- Which chemicals?
- Does a conservative evaluation indicate potential risk?

Tier 1. Screening Ecological Risk Assessment (SERA): Identify pathways and compare exposure point concentrations to benchmarks

Step 1: Site Visit; Pathway Identification/Problem Formulation; Toxicity Evaluation
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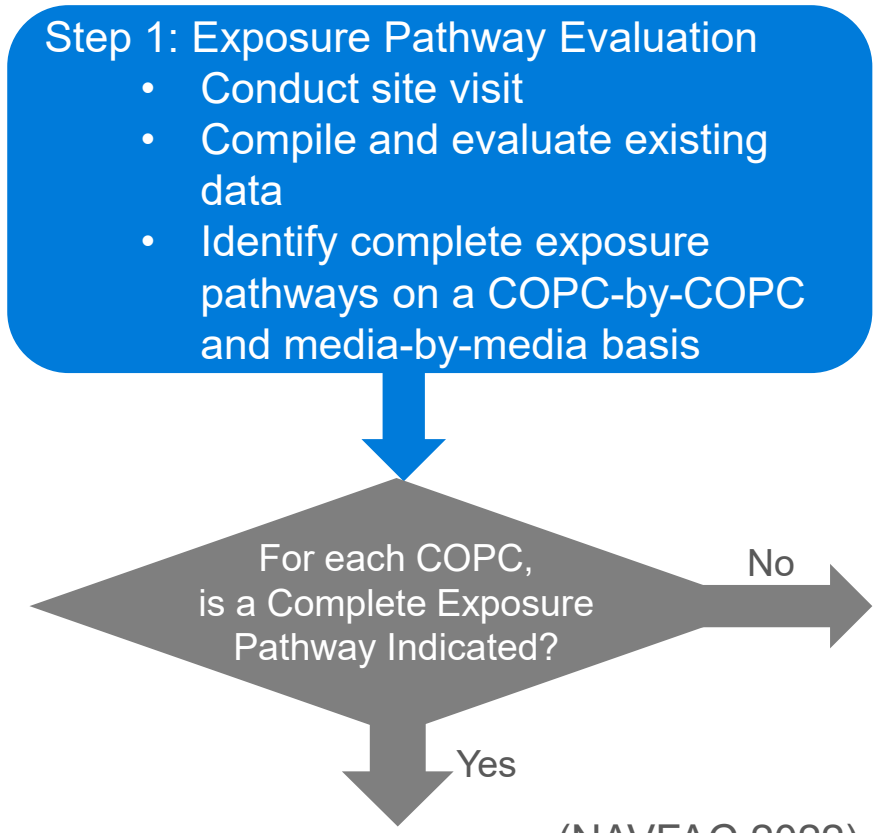
Proceed to Tier 2 or Interim Cleanup

(NAVFAC 2022)

Tier 1 SERA, Step 1: Planning

- Define objectives clearly and early
- Determine technical requirements
  - Sampling methods, lab methods, data evaluation plan
- Identify risk assessment expertise
- Initiate early discussions between risk assessors, RPMs, and other technical staff (engineers, geologists)
- Coordinate early with regulators and other stakeholders
- Conduct a site visit
  - RPMs should scope for the Ecological Risk Assessor to visit the site

Objectives and requirements get more complex with each tier

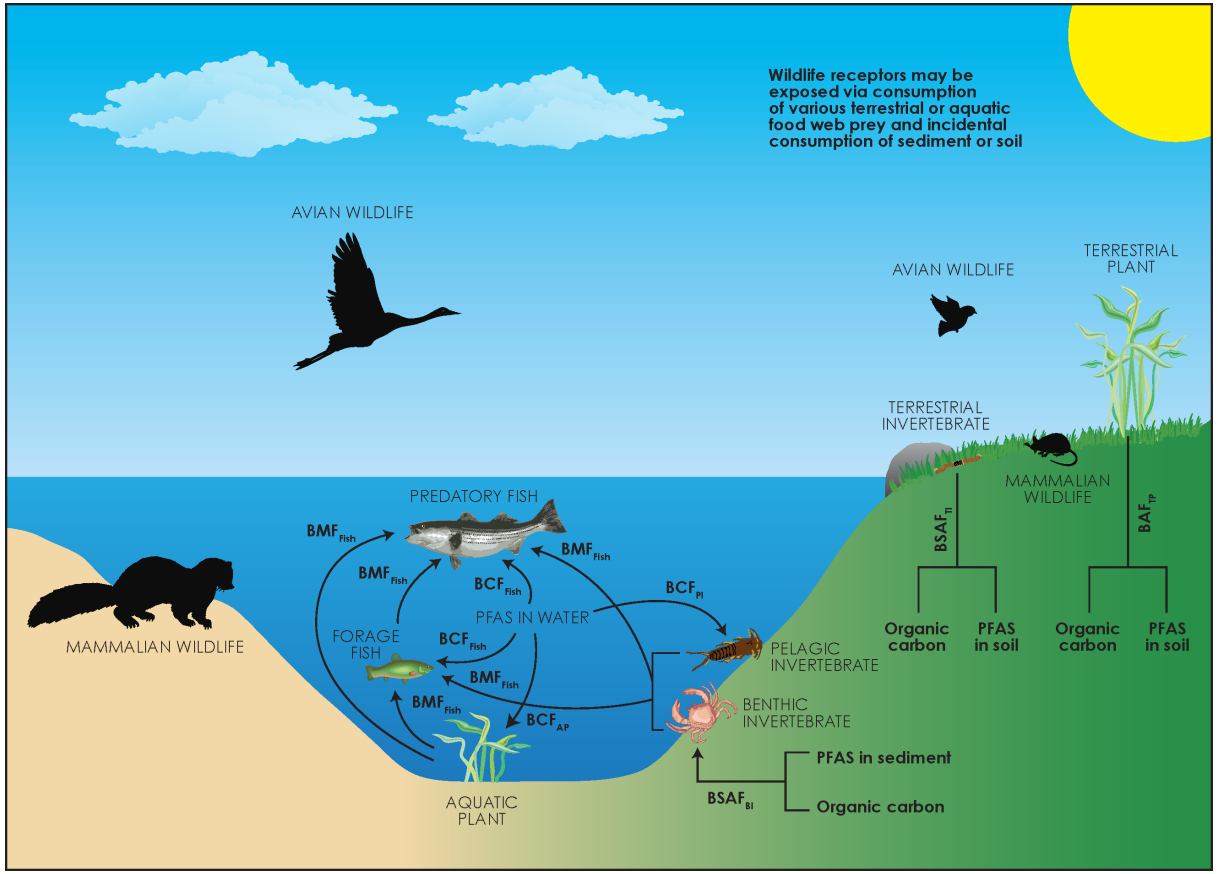


(NAVFAC 2022)

COPC: chemical of potential concern
RPM: remedial project manager

Tier 1 SERA, Step 1: Exposure Pathways

- What are your potential exposure pathways?
  - To have a risk, you must have a potential exposure
  - In ERAs, we evaluate current exposure
- What are your potential ecological receptors?
  - Terrestrial receptors
  - Aquatic receptors
  - Any Threatened or Endangered Species
- What are we trying to protect?
  - Assessment versus Measurement endpoints



Generic CSM
(Conder et al. 2020)

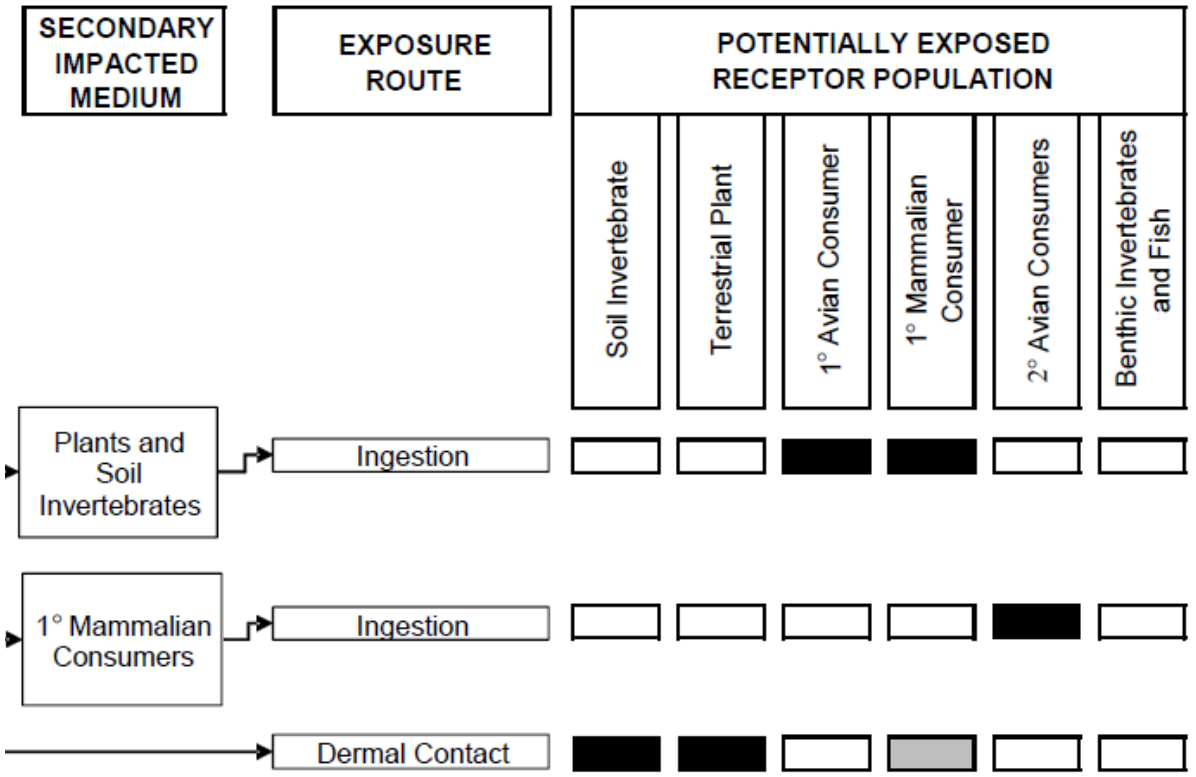
Tier 1 SERA, Step 1: Conceptual Site Models (CSMs)

- Do we need an ERA?
- What are the exposure pathways?
- **A CSM helps you organize**

☑ Chemicals
☑ Valued ecological receptors
☑ Exposure pathways

Notes:

- Complete exposure pathway that will be quantitatively evaluated.
- Potentially complete, but insignificant pathway.
- Incomplete exposure pathway; no evaluation or management action is necessary.



KEY POINT

CSMs provide a road map to which pathways require quantified assessment.

(Conder n.d.)

Tier 1 SERA, Step 1: Data Planning

- What abiotic data will you need to determine exposure to chemical concentrations in the Tier 1 SERA?
  - Soil, surface water, sediment (sediment porewater)?
  - What data do I have, and can it be used?
  - Will my data quality be adequate for conducting a Tier 1 SERA?
  - How much data do I need?

- Key data goal: EPC
  - A single number representing a concentration of a chemical (in soil, water, etc.) at your site
    - Tier 1 SERA, Step 1: maximum concentrations in abiotic media
    - Tier 2 BERA, Step 3a: 95 UCLs: USEPA's ProUCL tool is a good resource for calculating 95 UCLs
- In Step 1, EPCs can be compared to screening values and used in exposure models

BERA: baseline ecological risk assessment
EPC: exposure point concentration
SERA: screening ecological risk assessment
UCL: upper confidence limit

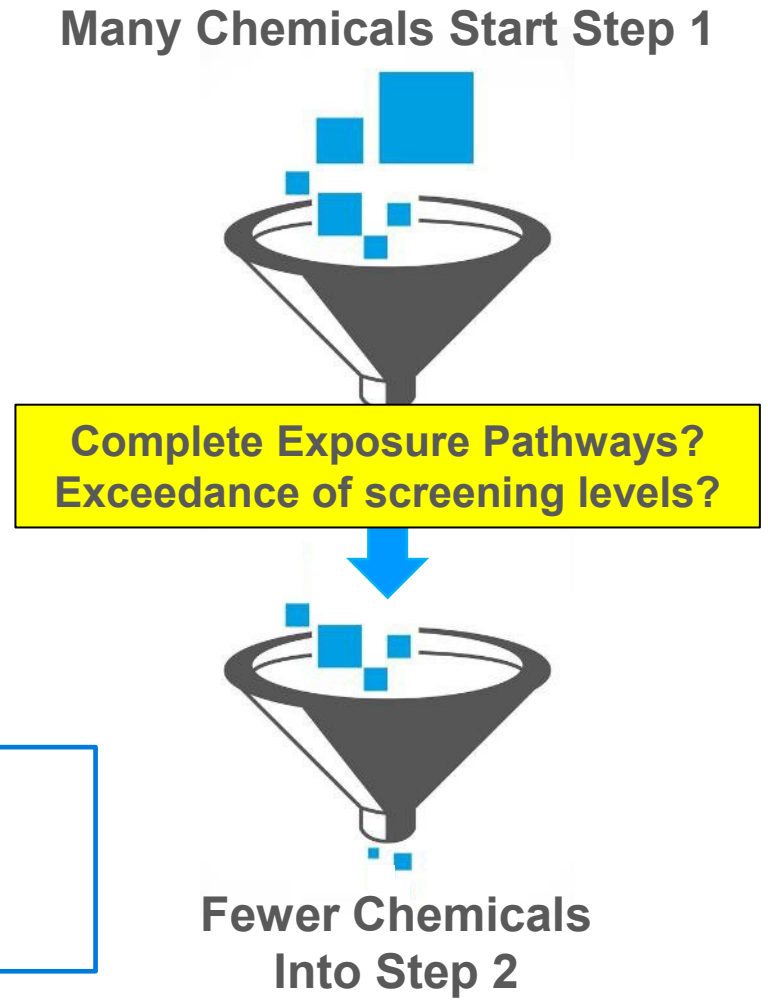
Tier 1 SERA, Step 1: Screening

- In Step 1, in addition to considering complete exposure pathways, EPCs are often compared to conservative screening values
- Chemicals that exceed conservative screening values proceed to Tier 1 SERA, Step 2

Basis of Screening Levels
- Established screening values (USEPA AWQC, Eco-SSLs, Biological Technical Assistance Group Region 3, Oak Ridge National Laboratory values)
- Literature-based values

KEY POINT

The Tier 1 SERA is a conservative screen intended to eliminate chemicals with no complete exposure pathways and eliminate chemicals present at "safe" concentrations.



(Conder n.d.)

AWQC: ambient water quality criteria
Eco-SSL: ecological soil screening level

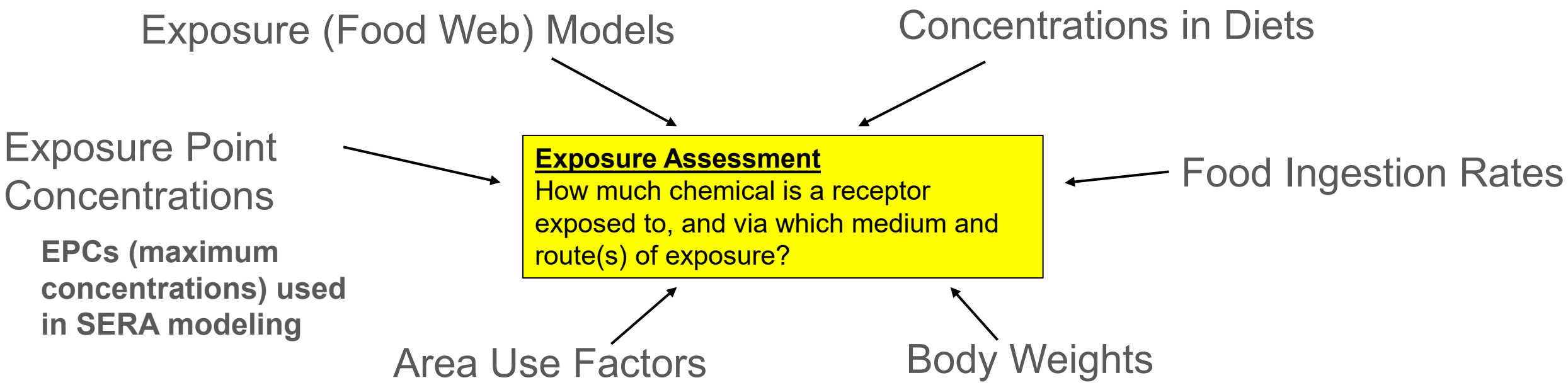
Tier 1 SERA, Step 2: Overview

Step 2: Conduct Exposure/Dose Estimation and Risk Calculation for Remaining COPCs

- Estimate exposure and dose using conservative assumptions
- Compile COPC-specific screening values
- Estimate risk potential using hazard quotient approach

(NAVFAC 2022)

Tier 1 SERA, Step 2: Exposure Assessment



KEY POINT

Exposure Assessment quantifies the amount of a chemical that receptors are exposed to (internal dose, or external media concentration).

(Conder n.d.)

Where Do Ecorisk Exposure Models Come From?

- In their most basic form, ecorisk models are a series of several Excel spreadsheets that use site EPCs to estimate site-specific exposures to selected representative ecological receptors
- Eco-Risk Assessors usually operate these models

$$DI = [\Sigma(Ci \times Fi \times FIR) + (Cs \times SIR)] \times AUF \times (1/BW)$$

Where:

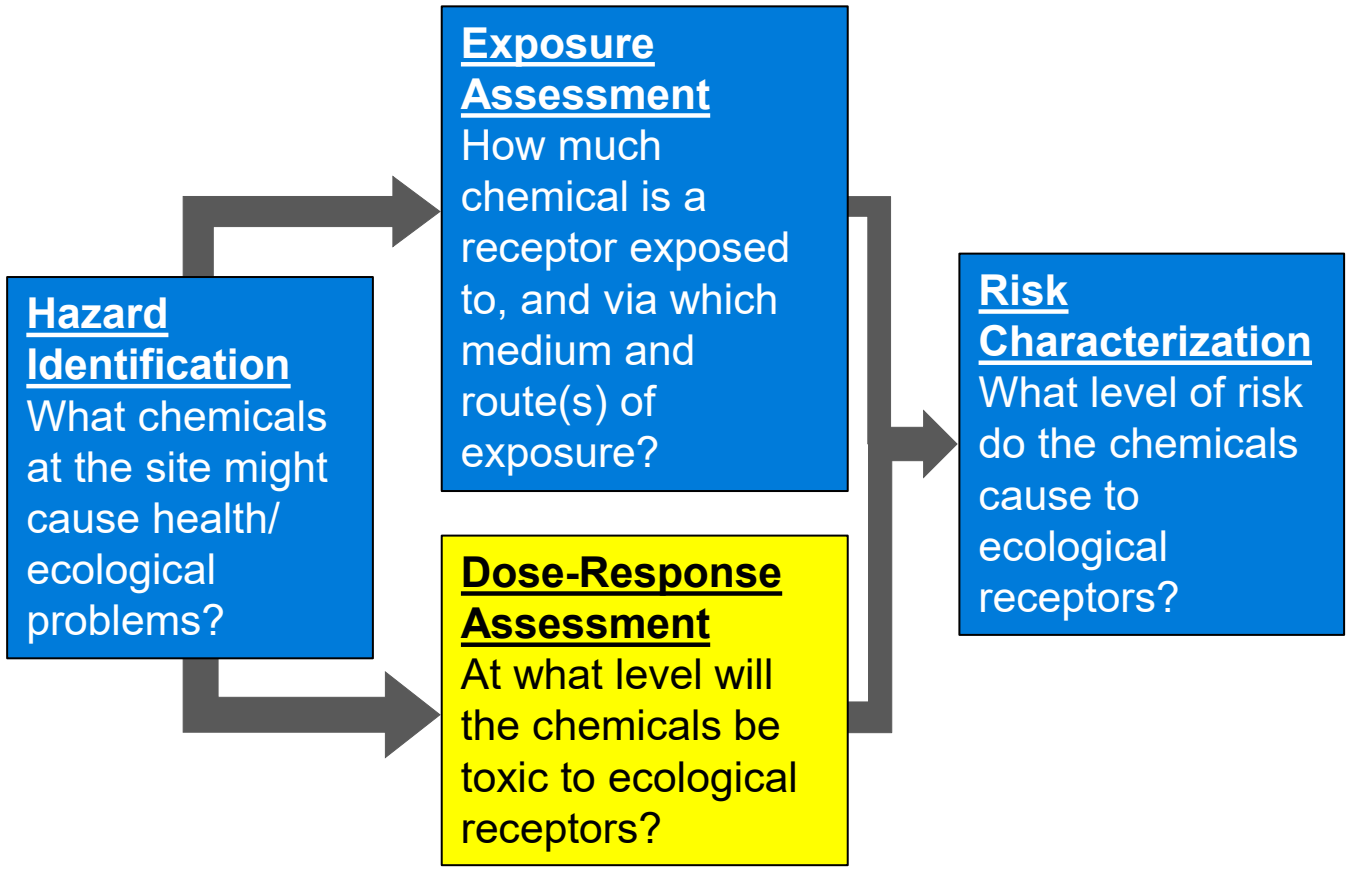
- DI = daily intake (dose) (mg/kg*day)
- Ci = concentration in food item i (mg/kg; wet weight)
- Fi = fraction of diet comprised of food item i (unitless)
- FIR = food ingestion rate (kg/day; wet weight)
- Cs = concentration in soil (or sediment) (mg/kg; dry weight)
- SIR = soil (or sediment) ingestion rate (kg/day; dry weight)
- AUF = area use factor (unitless, max of 1) = Home range ÷ Site Area
- BW = body weight (kg)

kg: kilogram
mg: milligram

(Conder n.d.)

Tier 1 SERA, Step 2: Effects Assessment

- Predicted exposures from the models divided by the Toxicity Reference Value (TRV) to calculate a Hazard Quotient (HQ)
  - HQ ≤ 1 = acceptable risk
  - HQ > 1 = potentially unacceptable risk (i.e., more work to do)



$$\text{Hazard Quotient} = \frac{\text{Exposure Value}}{\text{Toxicity Reference Value}}$$

Where do TRVs Come From?

- TRVs
  - Are also known as Screening Ecotoxicity Value (NAVFAC 2022 term), toxicity benchmark, no observed effect concentrations, lowest observed effect concentration, water quality criteria, etc.
  - Are based on dose response

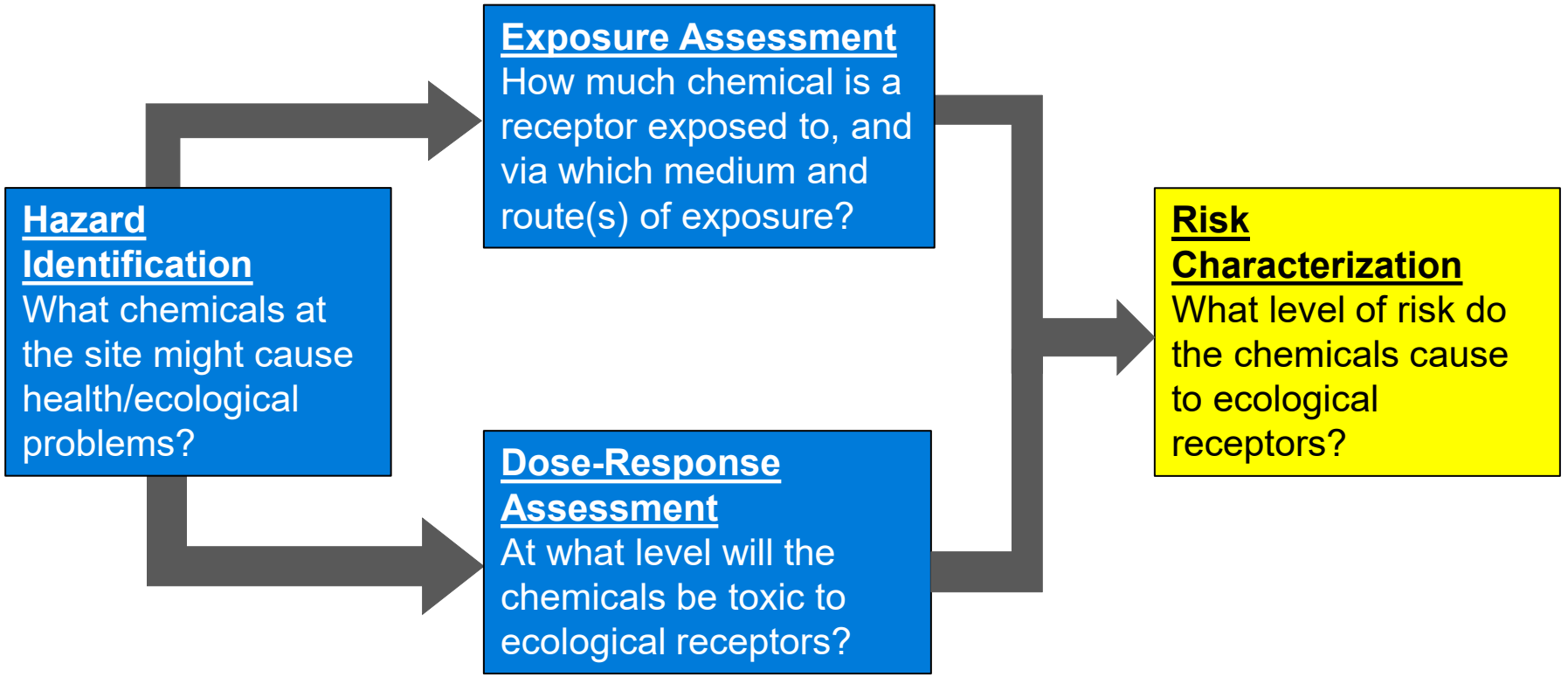
KEY POINT

The Dose-Response Assessment describes the relationship between the level of exposure and the likelihood and/or severity of an adverse effect.

- TRVs are usually derived from controlled experiments in which a laboratory organism is exposed to several doses of a chemical
  - Values obtained from peer-reviewed literature (usually)
  - USEPA and state environmental agencies may have preferred lists
    - Examples: USEPA Ecological Soil Screening Levels, AWQC

Tier 1 SERA, Step 2: Risk Characterization

- HQs are > 1, but
  - Communicate the uncertainties
  - Provide more detail on the assessment
  - Remind yourself and your readers that ERAs are conservative and hypothetical exercises
  - What's the predicted ecological outcome?

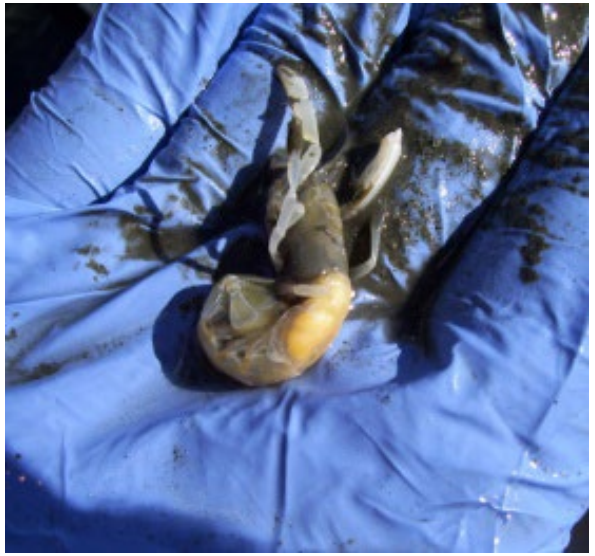


HQs > 1?: Common Misperceptions

(Pixabay n.d.)

(Pixabay n.d.)

HQs > 1?: Reality

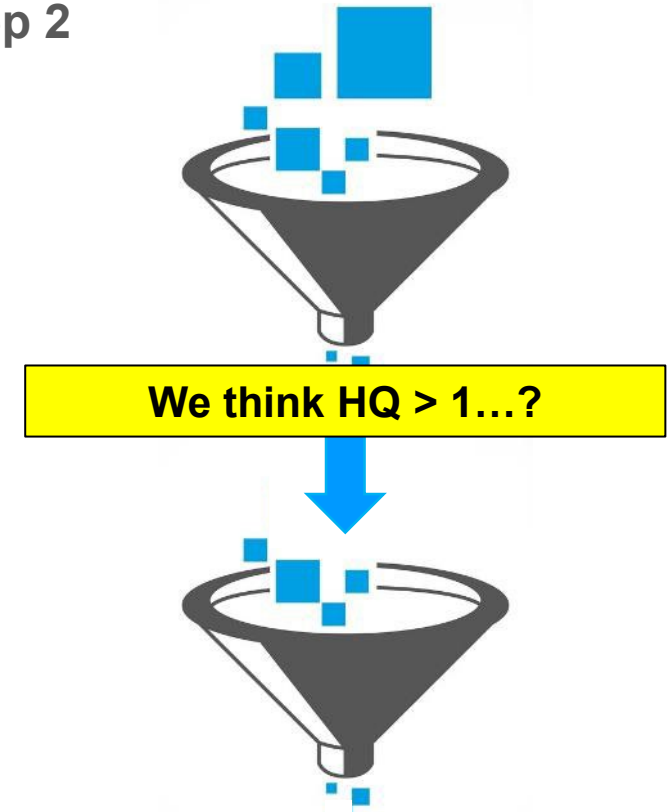





(Conder n.d.)

Tier 1 SERA, Step 2: Proceeding to Tier 2 Baseline Ecological Risk Assessment (BERA)

Fewer Chemicals Start Tier 1 SERA, Step 2



Even Fewer Chemicals Start Tier 2 BERA

(Conder n.d.)

Tier 2 BERA

- BERA
  - Does a ~~conservative~~ more realistic evaluation indicate potential risk?
  - If potential risk is indicated, should we collect more data?

Tier 2. BERA

Step 3a: Refinement of Conservative SERA Exposure Assumptions
Proceed to Exit Criteria for Step 3a

SMDP: Exit Criteria Step 3a
1) If re-evaluation of the conservative exposure assumptions (SERA) support an acceptable risk determination, then exit the ecological risk assessment process.
2) If re-evaluation of the conservative exposure assumptions (SERA) do not support an acceptable risk determination, then continue the BERA process.

Proceed to Step 3b

Step 3b: Problem Formulation—Toxicity Evaluation; Assessment Endpoints; Conceptual Model; Risk Hypothesis (SMDP)
Step 4: Study Design/DQO—Lines of Evidence; Measurement Endpoints; UFP-SAP (SMDP)
Step 5: Verification of Field Sampling Design (SMDP)
Step 6: Site Investigation and Data Analysis [SMDP]
Step 7: Risk Characterization
Proceed to Exit Criteria for BERA

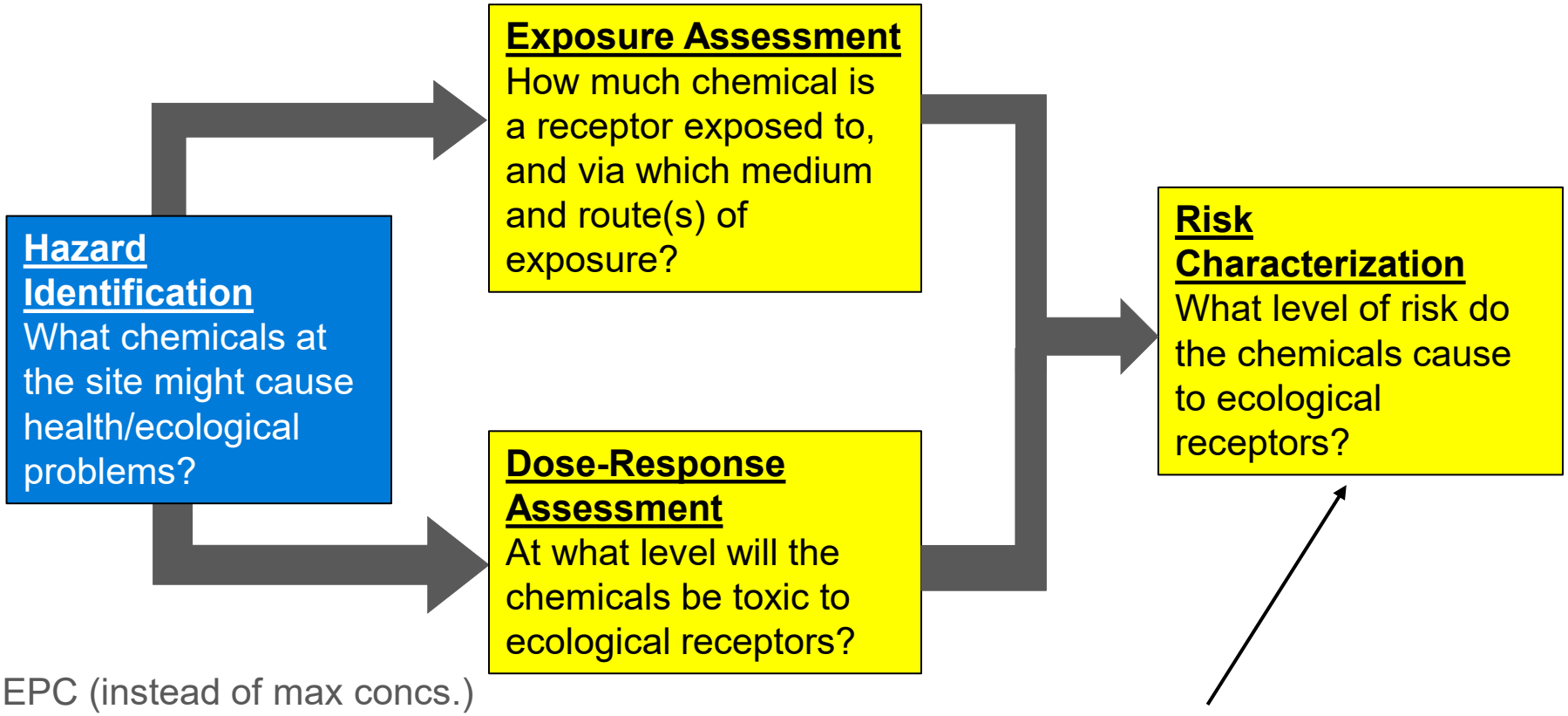
SMDP: Exit Criteria for the BERA
1) If the site poses acceptable risk, then no further evaluation and no remediation from an ecological perspective is warranted.
2) If the site poses unacceptable ecological risk and additional evaluation in the form of remedy development and evaluation is appropriate, proceed to third tier.

(NAVFAC 2022)

DQO: data quality objective
UFP-SAP: Uniform Federal Policy Sampling and Analysis Plan

Tier 2 BERA, Step 3a: Overview

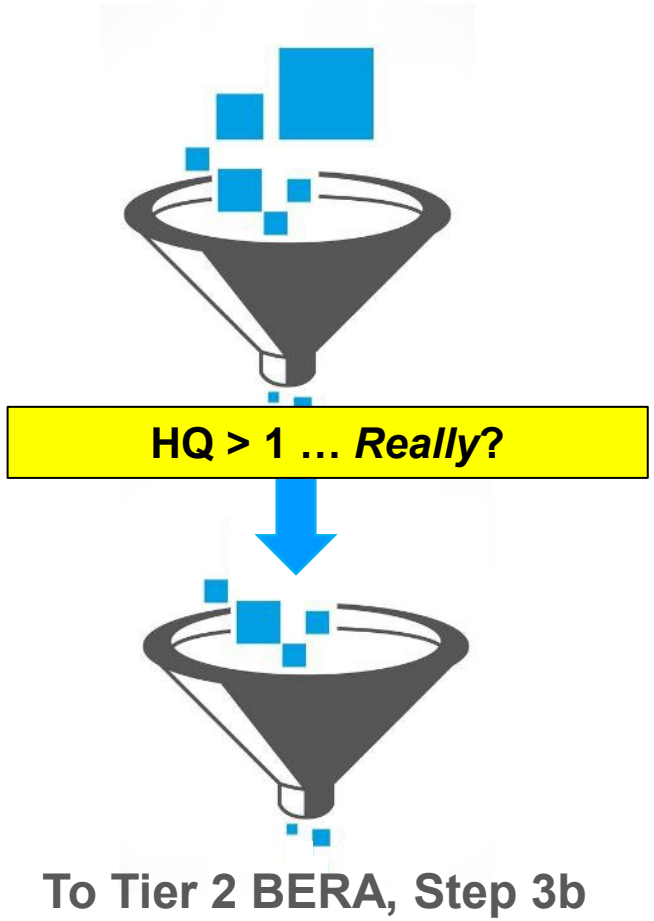
Tier 2 BERA, Step 3a:
Exposure and Effects calculations ***again***, but using less conservative* model assumptions to reduce uncertainty with site-specific considerations



*Examples
- 95 UCLs as the EPC (instead of max concs.)
- Assume the animals don't stay at the site 100% of the time
- Digestive availability that is not 100%

And more risk characterization ***again***

Tier 2 BERA, Step 3a: Proceeding to Tier 2 BERA

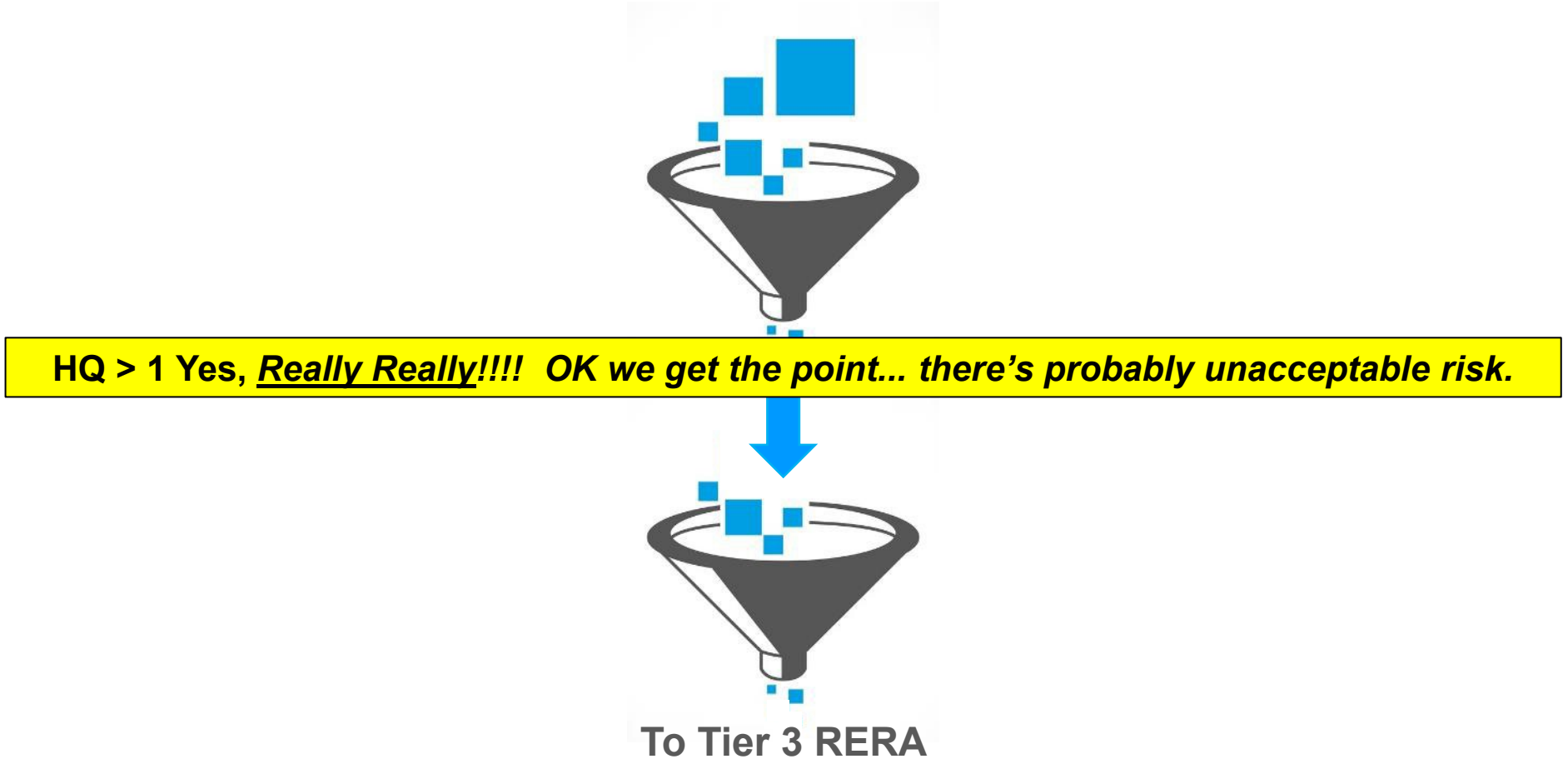


(Conder n.d.)

Tier 2 BERA: Step 3b and Beyond

- Making your risk assessment model more site-specific
- Collect more data and re-run HQs
- Examples of additional data collection
  - Measure concentrations of chemicals in wildlife diet items
  - Conduct toxicity testing
  - Evaluate site-specific bioavailability to refine exposure assessment
    - Total organic carbon, porewater passive sampling; simultaneous extracted metals/acid-volatile sulfide (AVS-SEM) for metals, etc.
  - Evaluate the predictions of the risk assessment model: Put the Eco in the Ecorisk!
    - Focused species surveys (wildlife studies)
    - Benthic invertebrate and aquatic census studies
    - Compare results to reference areas (if possible)

Tier 2 BERA: Proceeding to Tier 3 Risk Evaluation of Remedial Alternatives (RERA)



(Conder n.d.)

Tier 3 RERA

- RERA
  - Where do we remediate, how, and what's the cleanup goal?
    - Use existing models and data from the BERA
  - What's the risk to ecological receptors and habitat from a remediation?
    - Don't let the cure be worse than the disease

Tier 3. Evaluation of Remedial Alternatives (RAGS C)

a. Develop site-specific risk based cleanup values.
b. Qualitatively evaluate risk posed to the environment by implementation of each alternative (short-term) impacts and estimate risk reduction provided by each (long-term) impacts; provide quantitative evaluation where appropriate. Weigh alternative as appropriate. Plan for monitoring and site closeout.

(Pixabay n.d.)

RAGS C: Risk Assessment Guidance for Superfund Part C

ERA for PFAS – Pondering the Questions

- Can an ERA be done for PFAS?
  - Absolutely, but it will carry uncertainties that ERAs for other chemicals carry.
- What data gaps still exist?
  - Huge advances in knowledge within the last 10 years.
  - Marine aquatic life, avian toxicity, field studies to verify if what basic risk models predict are a reality, understanding toxicity of mixtures.
- Are there ambient anthropogenic background levels of PFAS that need to be considered (outside of a CERCLA release)?
  - Hmmm…can the expanding literature be ignored here?
- What exposures and particular PFAS will drive risk?
  - Not going to ruin Dr. Conder's thunder – Stay tuned to this channel (meeting)

Filling Some of the PFAS Data Gaps

- DoD SERDP/ESTCP conducting research to fill important data gaps.
  - Marine Aquatic Toxicity and Bioaccumulation
    - 2022 SON – Improved Understanding of Ecotoxicity of PFAS in the Marine Environment
  - Avian Toxicity and Bioaccumulation
    - 2022 SON –Improved Understanding of the Ecological Toxicity and Risk of PFAS in Avian
  - Ecotoxity of PFAS Mixtures
    - 2022 SON – Improved Understanding of the Ecotoxicity of Mixtures of PFAS

Importance of Field Studies

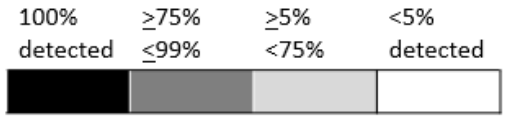
Total $PFAS_{13}$ in tree swallow diet samples (2020, 2021, 2022)
(aerial stage of aquatic insects n=1-2 composite/site/year)

Location	Concentration (ng/g) 2020	2021	2022	Study/Citation
Willow Grove-Runway	27.3	15.4	36.7	This study
Willow Grove – Rec. Pond	27.4	25.1	104	This study
Willow Grove – ANG			190	This study
Patuxent (ref.)	5.4	4.6	6.2	This study
Wurtsmith AFB	141 - 190			Custer et al. 2019
Dix		68.1	93.7	This study
Lakehurst		48.4	103	This study
Cape Cod		180	112	This study
North Tract (ref.)		7.57	9.0	This study

Percent of samples with concentrations greater than the detection limit, by matrix type in tree swallows 2020 – 2022 from sites along the East Coast and Upper Midwest, USA.

PFAS	egg	nestl.	plasma	diet
n =	164	81	72	11
PFBA	4	17	13	18
PFPeA		9		9
PFHxA	5	7		36
PFHpA	7	11	11	
PFOA	88			91
PFNA				91
PFDA				91
PFUnA		99		82
PFDoA		94	97	73
PFTrDA	97	83	76	36
PFTeDA	98	74	65	36
PFBS				
PFPeS	9	10	31	
PFHxS	84	98	99	73
PFHpS	72	60	85	36
PFOS				
PFNS	41	28	38	
PFDS	98	94	83	36
PFDoS	13	12	3	
PFOSA	29	48	15	36

PFAS cont.	egg	nestl.	plasma	diet
N-MeFOSA		1		
N-EtFOSA		1		
4:2 FTS	2	2		
6:2 FTS	21	25		64
8:2 FTS	47	19	31	64
N-MeFOSAA	24	38	22	
N-EtFOSAA	5	27	28	
N-MeFOSE				
N-EtFOSE	51	49		9
HFPO-DA				
ADONA	1			
9Cl-PF3ONS				
11Cl-PF3OUdS				
3:3 FTCA	1			
5:3 FTCA	26	20	6	
7:3 FTCA	81	58		
PFEESA				
PFMPA	2			
PFMBA	1	7		
NFDHA				



Both Graphics Provided via Dr. Christine Custer (USGS)

Summary and Closing Thoughts

- Ecological risk assessment for PFAS can be completed following the CERCLA ERA guidance.
  - Uncertainty will always exist
- Several areas of data gaps being filled through ongoing research
- Some level of exposure to PFAS and ecological receptors is going to be complete even in areas with no known CERCLA release.
  - What does that mean for risk management?
- There is a great deal to learn about presence of potential ecological risks from field studies.
  - As field studies are completed validation with suspected exposure, modeling predictions, and occurrence of ecologically relevant effects will help apply to future ERAs.
- Could a model like that used in the EPA's Eco-SSL effort be useful for assessing ecological risks from PFAS?
- My quote, "Let good science dictate and serve to develop policy, and not the other way around."

Photos from Dr. C. Custer

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Questions???