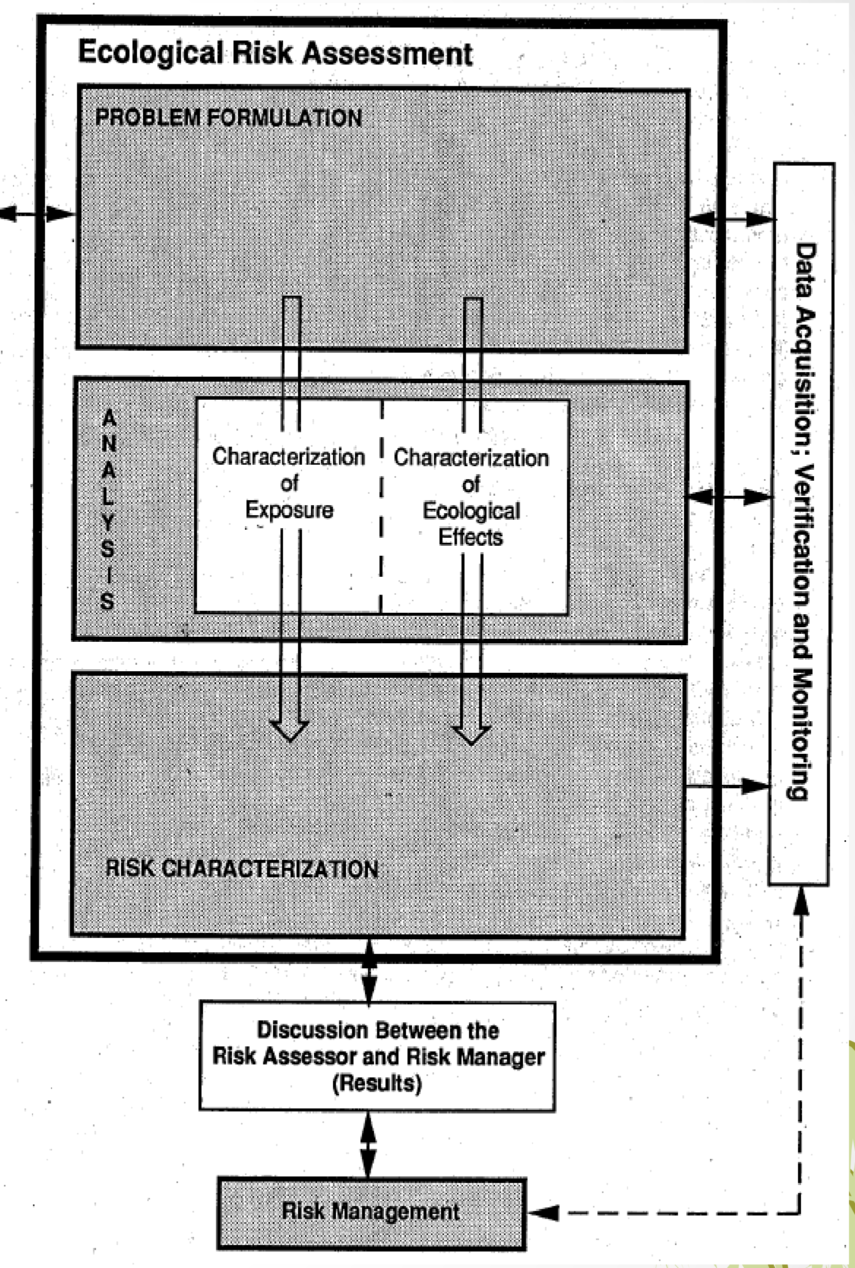
Status of Ecological Risk Assessment in Texas: On-Line Tools for Project Planning, Assessment and Decision Making

Margaret Roy
Pastor, Behling & Wheeler, LLC

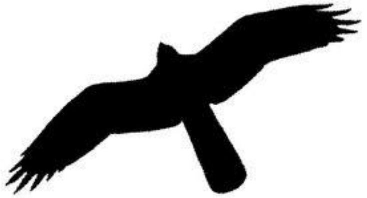
Where it all began

- human health and the environment
  - USEPA 1992. *Framework for Ecological Risk Assessment* (updated in 1998)
  - USEPA 1993. *Wildlife Exposure Factors Handbook*
  - USEPA 1997. *Ecological Risk Assessment Guidance for Superfund: Process for designing and conducting ecological risk assessments.*



Wildlife Exposures: Red-tailed hawk

- Body weight (g)
- Metabolic rate (kcal/kg-day)
- Food ingestion rate (g/g-day)
- Water ingestion rate (g/g-day)
- Inhalation rate (m^3/day)
- Surface area (cm^2)
- Dietary composition by season
- Territory size (ha)
- Population density



- Clutch size
- Clutches/year
- Growth rate by weeks
- Age at fledging (days)
- Number fledge per active nest
- Number fledge per successful nest
- Age of sexual maturity (yrs)
- Annual mortality rates
- Longevity

Source: EPA 1993

Hazard Quotient Analysis

$$\boldsymbol{Dose_{oral}} = \frac{[(\boldsymbol{IR_{food}} \times \boldsymbol{C_{food}}) + (\boldsymbol{IR_{water}} \times \boldsymbol{C_{water}}) + (\boldsymbol{IR_{soil}} \times \boldsymbol{C_{soil}}) + (\boldsymbol{IR_{sed}} \times \boldsymbol{C_{sed}})]}{\boldsymbol{BW}}$$

$$\mathrm{HQ} = \frac{Exposure}{TRV} = \frac{Dose}{TRV}$$

One chemical at a time

Toxicity Reference Dose (TRV) taken from the open literature

- Mortality
- Reproduction
- Developmental

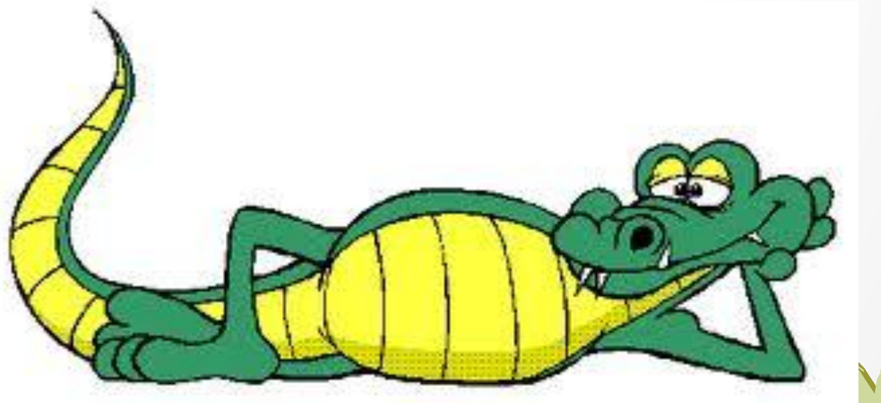
Environmental Vogue

- Emerging Contaminants
  - 1,4-Dioxane
  - PFOS/PFOA
- Endocrine disruptors
  - Phthalates
  - BPA

Endocrine Disruptors

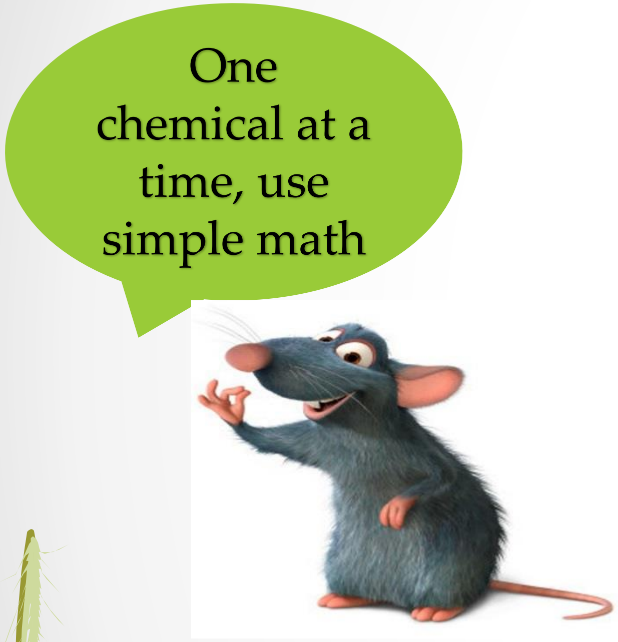
Early studies of alligators led biologists to realize that something in the environment was affecting their reproduction. Juvenile female alligators had malformed ovaries, while males had lower than average testosterone levels and a small penis. Researchers have discovered that the changes were caused by environmental contaminants, which were acting as endocrine disruptors (Science News – January 5, 2014).

- Organochlorine pesticides (DDT)
- PCBs
- Synthetic estrogen



How did I get here?

What am I doing with my life?



Ecological Risk Assessment

- Conducting Ecological Risk Assessments at Remediation Sites in Texas (ERAG) (RG-263)
- Screening Level Benchmarks (RG-263B)
- PCL Database for Wildlife
  - Sediment
  - Soil
  - Based on the 7 major habitats in Texas
  - Minor Habitat (aquatic and terrestrial)
- All released in January 2017

ERAG and Benchmark Updates

- ERAG began in the 1990s – workgroup
- Released in 2001, updates in 2006 and 2014
- ERAG 2017 reorganized around the 10 required elements
- Updated the science
- Accessible (e-reader)
- Process did not change!

- Benchmarks now Excel-based
- Acute SW values added
- Sediment second effects and benthic PCLs listed
- Radionuclide screening values added
- TCEQ working to verify LC_{50} - based values
- Planned updates

TCEQ Web Pages

www.tceq.texas.gov/remediation/eco/eco.html

- Ecological Risk Resource page
- ERAG, benchmarks, link to Database
- TRRP-15eco (Representative Concentrations)
- TRRP-24 (Determining PCLs for SW and Sed)

(don't forget Surface Water Program)

www.tceq.texas.gov/remediation/trrp/guidance

- Guidance and Forms

PCL Database

- Calculates Sediment and Soil Wildlife PCLs
- Birds, Mammals, Reptiles and Amphibians
- 7 Major habitats plus Minor Habitat
- Can incorporate home range and seasonality factors
- Modify uptake factors or TRVs
- Export to Excel
- Resource for:
  - Species information
  - TRVs
  - Uptake factors (e.g., soil to earthworm, soil to arthropod)

PCL Database

pcl.wtamu.edu/pcl/login.jsp

- Guest users not allowed to export
- Register Now!

West Texas A&M
UNIVERSITY

Version: PCL1.8

TCEQ

Protective Concentration Levels Calculator

User: Margaret Roy
Role: Administrator 24.242.70.51

Log Out

PCL Calculator | Chemicals | Species | Habitat | User Maintenance | Contact Us

Step 1: Select desired habitat or select from the species list.

○ Habitat ○ Species

Step 2: Select either the chemical name or CAS.

Chemical: choose by name or CAS

Choose Chemical by Name	Choose Chemical by CAS
1,1,2,2-TETRACHLOROETHANE	014797-73-0
1,1-DICHLOROETHANE	100-41-4
1,2,4-TRICHLOROBENZENE	100-42-5
1,2-DICHLOROBENZENE	106-44-5
1,2-DICHLOROETHANE	106-46-7

Step 3 Click "Next" to compute PCLs for Growth, Reproduction and Mortality

Next

Chemicals List | Add/Edit Chemical | Add/Edit Concentrations

CAS	Chemical Name									
99-35-4	1,3,5-TRINITROBENZENE (TNB)									
106-46-7	1,4-DICHLOROBENZENE									
118-96-7	2,4,6-TRINITROTOLUENE (TNT)									
121-14-2	2,4-DINITROTOLUENE									
35572-78-2	2-AMINO-4,6-DINITROTOLUENE									
19406-51-0	4-AMINO-2,6-DINITROTOLUENE (4-AM-DNT)									
67-64-1	ACETONE									
309-00-2	ALDRIN									
84-65-1	ANTHRAQUINONE									
7440-36-0	ANTIMONY									
12672-29-6	AROCLOR 1248									
11097-69-1	AROCLOR 1254									
11096-82-5	AROCLOR 1260	6.3	0.000014	0.168	0.28	0.149	0.19	60.6	4.67	TRRP,2017
7440-38-2	ARSENIC	0.68	0.15	0.0375	0.224	0.0703	0.0025	0.226	0.127	TRRP,2017
22541-54-4	ARSENIC (AS ARSENIC III)	0	0.15	0.0375	0.224	0.0703	0.0025	0.226	0.127	TRRP,2017
7440-39-3	BARIUM	0	16	0.156	0.091	0.031	0.0566	0.28	2.8	TRRP,2017
71-43-2	BENZENE	1.993	0.13	1.36	5.1	2.55	0.1	0.1	0.1	TRRP,2017
7440-41-7	BERYLLIUM	0.57	0.0053	0.208	0.045	0.0211	0.0408	0.125	0.125	TRRP,2017
92-52-4	BIPHENYL, 1-1	3.76	0.014	1.8	2.28	1.14	1.46	0.958	0.129	TRRP,2017
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE (DEHP)	8.39	0.3	0.07	0.67	0.335	0.1	15.3	7.35	TRRP,2017

FATE AND TRANSPORT/TOXICOLOGICAL PROFILE FOR ARSENIC

CASRN: 7440-38-2

Texas median soil background concentration is 5.9 mg/kg (TCEQ 2009). If PCL for soil is below 5.9 mg/kg, default to this value.

Environmental Fate & Exposure:

Environmental Fate/Exposure Summary:
Arsenic is the 20th most abundant element in the earth's crust. It occurs most often as a compound with sulfide in a variety of complex minerals. Other important natural sources of arsenic in the environment are from volcanic eruptions. From the mid-19th century to 1940s, inorganic arsenic compounds were the dominant pesticides available to farmers and fruit growers. Around the 1960s, the use of inorganic arsenic compounds in agriculture disappeared. However, some arsenic pesticides are still used today. The production and use of arsenic compounds as wood preservatives (e.g., chrome copper arsenate) and pesticides (eg, cacodylic acid) will result

Chemicals List | Add/Edit Chemical | Add/Edit Concentrations

Default Bioaccumulation Factors (BAFs) for Phenol

Soil-to-plant: 1.36
Justification: No data available; value is the geometric mean of soil-to-plant BAFs for organics with low Log K_{ow} values (<2.8). The EPA (2007) Figure 5B equation was not used because the Log K_{ow} was below the applicability domain of the compounds for which the model was developed (2.8 – 8).
Soil-to-earthworm: 7.41
Justification: No empirical soil-to-earthworm BAFs were found; BAF calculated using Jager (1998) regression for earthworms as per EPA (2007) using Log K_{ow}/Log K_{oc} values from TCEQ (2016).
Soil-to-arthropod: 3.71
Justification: Due to the lack of empirical BAFs, the soil-to-earthworm BAF was multiplied by an earthworm-to-arthropod attenuation factor of 0.5 (geometric mean of values for semi-volatile organics).
Soil-to-mammal: 0.1
Justification: No empirical data was found in the literature; phenol is a semi-volatile to volatile organic compound that is not halogenated and expected to be rapidly metabolized in small mammals. The geometric mean of soil-to-mammal BAFs for organics (1.46 was not used since this value is mostly based on data for chlorinated organic compounds (e.g. DDT and metabolites, dioxins and furans, and dieldrin) which are poorly metabolized.
Sediment-to-benthic invertebrates: 1.19
Justification: No empirical data could be found in the literature for phenol or a structurally similar surrogate compound. Value is the geometric mean of BAFs for munitions & explosives; even though phenol is not a munition or explosive compound, it is similar in structure and behavior (e.g., Log K_{ow}) to the M&E compounds (e.g., 2,4,6-TNT, HMX, RDX). The geometric mean of BAFs for semi-volatile organic compounds was not used because this dataset is based

8.50 x 11.00 in

CAS	Chemical Name	I								
75-09-2	METHYLENE CHLORIDE(DICHLOROMETHANE)									
22967-92-6	METHYLMERCURY									
7439-98-7	MOLYBDENUM									
110-54-3	N-HEXANE									
91-20-3	NAPHTHALENE									
7440-02-0	NICKEL									
98-95-3	NITROBENZENE									
29082-74-4	OCTACHLOROSTYRENE									
106-44-5	P-CRESOL									
87-86-5	PENTACHLOROPHENOL									
014797-73-0	PERCHLORATE									
108-95-2	PHENOL									
7723-14-0	PHOSPHORUS, TOTAL (AS P)	3.08	0	0.129	0.301	0.0753	0.0408	0.171	0.3	TRRP,2017
1336-36-3(D)	POLYCHLORINATED BIPHENYLS (PCBs), DIOXIN-LIKE (AS 2,3,7,8-TCDD TEQs)	6.3	0.000014	0.168	0.28	0.149	0.19	56	4.67	TRRP,2017
1336-36-3	POLYCHLORINATED BIPHENYLS (PCBs), TOTAL	6.3	0.000014	0.168	0.28	0.149	0.19	60.6	4.67	TRRP,2017
130498-29-2	POLYCYCLIC AROMATIC HYDROCARBONS, TOTAL	0	0.0338	2.22	3.62	1.81	0	0.197	2.32	NA
130498-29-2(HMW)	POLYCYCLIC AROMATIC HYDROCARBONS-HIGH MOLECULAR WEIGHT	0	0.00996	0.342	1.77	0.885	0	0.0644	2.36	NA
130498-29-2(LMW)	POLYCYCLIC AROMATIC HYDROCARBONS-LOW MOLECULAR WEIGHT	0	0.0542	4.57	5.93	2.97	0	0.431	2.25	NA
7757-79-1	POTASSIUM NITRATE	-0.79	0	0.129	0.301	0.0753	0.0408	0.171	0.3	SYRACUSE RESEARCH CORPORATION

Species List | Add/Edit Species | Surrogate Assignment

Species Name	Class Name	Habitats	Body Weight	Trophic Level										
BARRED TIGER SALAMANDER (TR)	AMPHIBIAN		0.054	4										
CENTRAL NEWT (TR)	AMPHIBIAN		0.0026	3										
LEOPARD FROG (AQ)	AMPHIBIAN		0.1	4										
WOODHOUSE TOAD (TR)	AMPHIBIAN		0.056	3										
AMERICAN KESTREL (TR)	BIRD		0.116	4										
AMERICAN ROBIN (TR)	BIRD		0.0773	3										
AMERICAN WIGEON (AQ)	BIRD		0.755	2										
AMERICAN WOODCOCK (TR)	BIRD		0.169	3										
BALD EAGLE (AQ)	BIRD		3.75	3										
BARN OWL (TR)	BIRD		0.466	4										
BARN SWALLOW (TR)	BIRD		0.016	3										
BELTED KINGFISHER (AQ)	BIRD		0.148	4										
BEWICK S WREN (TR)	BIRD		0.01	3										
BLACK CAPPED VIREO (TR)	BIRD		0.009	3	0.282	0.00282	0.279	1.0	0.0	0.0	1.0	0.0	0.0	0.0
BLACK CROWNED NIGHT HERON (AQ)	BIRD		0.87	4	0.08675404	0.005379	0.061775	6.0	0.0	0.0	0.0	0.0	0.5	0.5
BOBWHITE QUAIL (TR)	BIRD		0.18	3	0.0723	0.00672	0.115	9.3	0.75	0.0	0.25	0.0	0.0	0.0
BURROWING OWL (TR)	BIRD		0.15	4	0.123154	0.006158	0.110342	5.0	0.0	0.0	0.8	0.2	0.0	0.0
CANADA GOOSE (AQ)	BIRD		3.0	2	0.051230367	0.004201	0.041058	8.2	1.0	0.0	0.0	0.0	0.0	0.0
COMMON YELLOW THROAT (TR)	BIRD		0.01065	3	0.26873586	0.005375	0.264135	2.0	0.0	0.0	1.0	0.0	0.0	0.0

Barn Owl
Tyto alba

Factors	Age/Sex	Mean	Range	Location	Reference
Body Weight (g)	AM AF (n=129) AM AF (n=37)	291 305 442 490	Unknown Unknown 382-580 299-580	Britain NR	Newton et al. (1997)[1] Dunning (1984), Sample and Suter (1994)
Home Range (acres)	AM, AF AM, AF NR	741 (3 km^2) 1853 (7.5 km^2) 618 (250 ha)	 1235-2471 (5-10 km^2)	Southern England Netherlands NR	Bond et al. (2004) de Bruijn (1984) Johnsgard (1988), Sample and Suter (1994)
Food Ingestion Rate (kg/kg-d)		0.0858 [2] 0.107	0.0687-0.103 [2] N/A	NR Calculated	Johnsgard (1988), Sample and Suter (1994) Nagy (2001)

Minor Habitat

▼	MINOR	MINOR	Fragmented ecological habitat or isolated island-like areas that cannot easily be categorized among the seven major habitats (e.g., an unmaintained grassy area adjacent to a laydown yard or a small, man-made stock pond). Included species are representative of a variety of feeding guilds and are useful for generalized PCL analysis.

AMERICAN ROBIN (TR)	AMERICAN WOODCOCK (TR)	BELTED KINGFISHER (AQ)	BOBWHITE QUAIL (TR)	DEER MOUSE (TR)	DESERT SHREW (TR)
EASTERN COTTONTAIL (TR)	GREEN HERON (AQ)	LEAST SHREW (TR)	MARSH RICE RAT (AQ)	MARSH WREN (AQ)	MOURNING DOVE (TR)
NINE-BANDED ARMADILLO (TR)	PLAIN-BELLIED WATER SNAKE (AQ)	RACCOON SEMI-AQUATIC (AQ)	RACCOON TERRESTRIAL (TR)	RED FOX (TR)	RED-TAILED HAWK (TR)
SOUTHERN SHORT-TAILED SHREW (TR)	SPOTTED SANDPIPER (AQ)	TEXAS RAT SNAKE (TR)	WHITE FOOTED MOUSE (TR)	YELLOW CROWNED NIGHT HERON (AQ)	

Habitat: MINOR HABITAT

Chemical: ARSENIC(CAS: 7440-38-2)

Log K_{ow} : 0.68

swqb : 0.15 mg/L

BAF - soil to plant: 0.0375

BAF - soil to earthworm: 0.224

BAF - soil to arthropod: 0.0703

BAF - soil to wildlife: 0.0025

BAF - sediment to fish: 0.226

BAF - sediment to benthic invertebrate: 0.127

Texas Median Soil Background: 5.9 (mg/Kg)

Legend:

- Value from Literature
- Calculated Value
- User Overridden Value
- Calculated from Overridden Value(s)

Species	Body Wt.	BAF	Food IR	Water IR	Soil Sed IR	End-point	Literature NOAEL	Literature LOAEL	Literature LD 50	Surrogate Used	Conservative PCL	TRV NOAEL	TRV LOAEL	Average TRV PCL	AUF %	EF %	Other EMF	Refined PCL
						GROW				MALLARD	39.118	1.73	17.3	215.14				0
AMERICAN ROBIN (TR)	0.0773	0.13075	0.242	0.13733	0.012584	MORT				MALLARD	84.114	3.72	37.2	463	100.	100	100	0
						REPR				CHICKEN	50.65	2.24	22.4	278.57				0
						GROW				MALLARD	41.764	1.73	17.3	229.70				0
AMERICAN WOODCOCK (TR)	0.169	0.20863	0.1325	0.10608	0.01378	MORT				MALLARD	89.804	3.72	37.2	494	100.	100	100	0
						REPR				CHICKEN	54.076	2.24	22.4	297.41				0
						GROW				MALLARD	47.492	1.73	17.3	261.20				373
BELTED KINGFISHER (AQ)	0.148	0.21115	0.15759	0.11083	0.003151	MORT				MALLARD	102.12	3.72	37.2	562	70	100	100	803
						REPR				CHICKEN	61.493	2.24	22.4	338				483

PCL Database

- Agency accepted inputs (body weight, home range)
- Allows the user to know PCLs at the beginning
  - Compare to Human Health PCL
  - Preliminary Critical PCL
- Aid in planning assessment or additional data collection
  - Use PCLs as assessment levels (detection limit check)
  - Tool for defining Affected Property boundary
- Development of memos to exit a process without a SLERA

PCL Database Example

- Facility located next to a wetland
- Conceptual model indicated that there could have been runoff of copper into adjacent wetland
- 2 sediment samples and 2 soil samples collected
- Concentrations ranged from 17 – 56 mg/kg.
- Is a SLERA the next step?

- PCL Database – Freshwater Systems
- Lowest Conservative PCL = 89.37 mg/kg (Common Yellow Throat)
- Benthic PCL = 90.3 mg/kg
- Develop memo with maps
- Present data and CSM
- Show PCLs from Database
- Done!

Habitat:	FRESHWATER SYSTEMS	BAF - soil to plant:	0.124
Chemical:	COPPER(CAS: 7440-50-8)	BAF - soil to earthworm:	0.515
Log K_{ow} :	-0.57	BAF - soil to arthropod:	0.946
swqb :	0.00524 mg/L	BAF - soil to wildlife:	0.2412

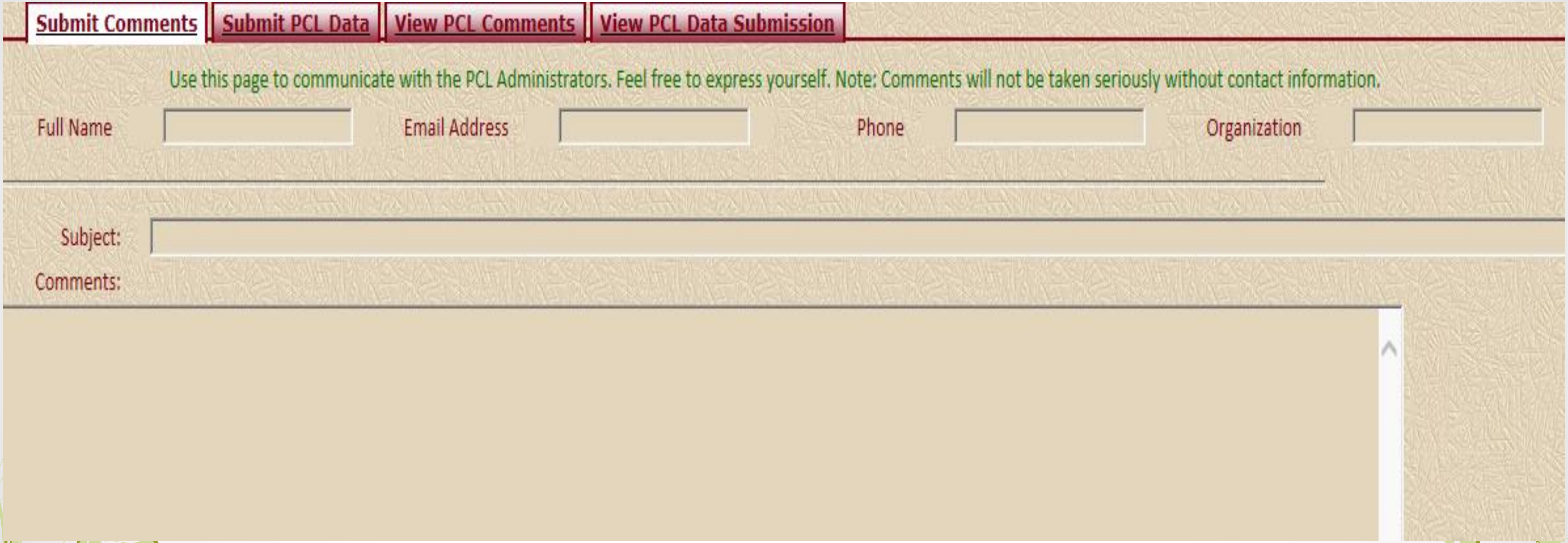
BAF - sediment to fish:	0.361
BAF - sediment to benthic invertebrate:	0.661
Texas Median Soil Background:	15 (mg/Kg)

Legend:

- Value from Literature
- Calculated Value
- User Overridden Value
- Calculated from Overridden Value(s)

Species	Body Wt.	BAF	Food IR	Water IR	Soil Sed IR	End-point	Literature NOAEL	Literature LOAEL	Literature LD 50	Surrogate Used	Conservative PCL	TRV NOAEL	TRV LOAEL	Average TRV PCL	AUF %	EF %	Other EMF
CANADA GOOSE (AQ)	3	0.124	0.05123	0.04106	0.004201	MORT				CHICKEN	3127	33	43.3	3615	100.	100	100
						REPR				CHICKEN	2198	23.2	29.9	2516			
						GROW				CHICKEN	89.369	23.2	29.9	102.27			
COMMON YELLOW THROAT (TR)	0.01065	0.946	0.26874	0.26414	0.005375	MORT				CHICKEN	127.11	33	43.3	146.95	100.	100	100
						REPR				CHICKEN	89.369	23.2	29.9	102.27			
						GROW				RAT	891	82.5	165	1337			
COTTON MOUSE (TR)	0.043	0.6994	0.12868	0.168	0.002573	MORT				MOUSE	365	33.8	101	728	100.	100	100
						REPR				MOUSE	982	90.9	136	1226			
						GROW				--		-	-	-			
COTTONMOUTH WATER MOCASSIN (AQ)	0.3177	0.32506	0.007908	0	0.000355	MORT				--		-	-	-	100.	100	100
						REPR				--		-	-	-			
						GROW				RAT	9652	82.5	165	14477			
COYOTE (TR)	13	0.2412	0.03175	0.0766	0.000889	MORT				MOUSE	3954	33.8	101	7885	100.	100	100
						REPR				MOUSE	10634	90.9	136	13272			

PCL Database – Work in Progress

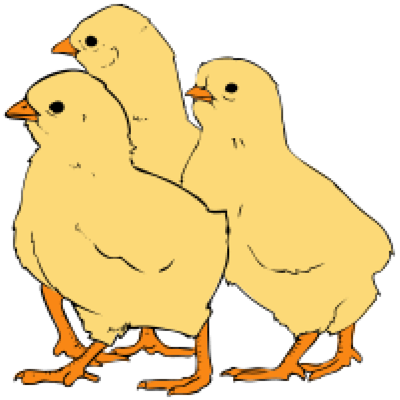


Ecological Risk Assessment - Texas

- Know your site
- Protected Species
- Use the Tier 1 Exclusion Criteria Checklist
- Get the data from habitat areas (TRRP-15eco)
- Understand hot spots; consider surgical removals
- Use statistics (95% UCL)
- Don't forget about Ecological Services Analysis (ESA)

Ecological Risk Assessment - Texas

- TCEQ welcomes input, new data, new ideas
  - Trail Cameras – Horned Lizard
- Don't be afraid of site-specific data, but develop a Tier 3 work plan to focus efforts
  - Tissue Concentrations
  - Uptake Studies
- Cost/Benefit
- Remember that the industry is young – limited data
  - One TRV for reptiles – lead
  - TRVs for birds – chicken
  - TRVs for mammals – rat/mouse



Margaret Roy
margaret.roy@pbwllc.com
512-913-5142